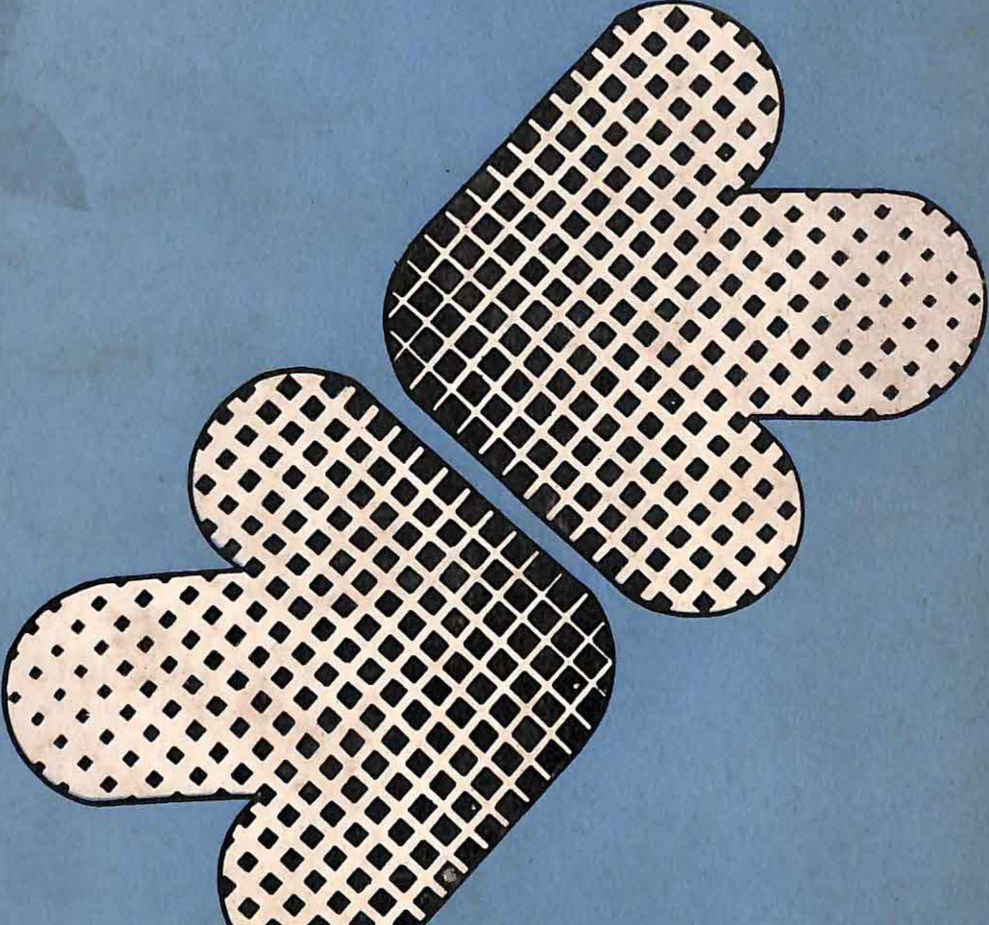
CHEMISTRY

OBJECTIVE TYPE QUESTIONS WITH ANSWERS

For Civil Services and other Competitive Examinations



M. Singh **G. Raj**

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Chemistry : Objective Type Questions

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PREFACE

The Union Public Service Commission has introduced the new pattern of examination for recruitment to the Central Civil Services (preliminary). This type of pattern is also adopted by many service commissions and other Regional Recruitment Boards. The present book has been written according to this new pattern of objective type questions. The 1100 carefully selected questions are provided with multiple choice answers, covering all branches of chemistry within the limited space available.

These questions are so framed that they clear minute misconceptions in the fundamentals of the subject. Useful conversions and important reactions are also incorporated. Before doing these questions, the student is expected to know the fundamental concepts of chemistry.

We look forward to the comments and suggestions from students/teachers for modifications and improvements in subsequent editions.

Authors

PREFACE

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These questions are so framed that they cover almost [illegible] all important aspects of the subject [illegible] concepts and important theories are also incorporated. While doing these questions, the student gets sound knowledge of the fundamental concepts of chemistry.

Welcome [illegible] to the [illegible] and suggestions from students/teachers for modification and improvement of the present edition.

Author.

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PART I

Physical Chemistry

1

KINETIC THEORY OF MATTER

1. The ratio of root-mean square velocity to average velocity of a gas molecule, at a particular temperature is
   (a) 1.086 : 1 (b) 1 : 1.086
   (c) 2 : 1.086 (d) 1.086 : 2
2. The relative rate of diffusion of a gas (mol. wt. = 98) as compared to hydrogen will be
   (a) 1/7 (b) 1/5 (c) 2/5 (d) 1
3. Suppose two bulbs having different gases at the same temperature but different pressures are connected together, the pressure of the gas mixture when they do not react together would be
   (a) equal to the sum of their pressures
   (b) more than the sum of their pressures
   (c) less than the sum of their pressures
   (d) none of the above is correct.
4. What gas laws have been explained on the basis of kinetic gas equation ?
   (a) Avogadro's law (b) Boyle's law
   (c) Charle's law (d) All of the above laws
5. If two moles of an ideal gas at 546°K occupies a volume of 44.8 litres, the pressure must be
   (a) 1 atmosphere (b) 2 atmosphere
   (c) 3 atmosphere (d) 4 atmosphere
6. The energy of molecular motion appears in the form of
   (a) friction (b) heat
   (c) potential energy (d) temperature
7. Root mean square velocity 'u' of a gas is related to the temperature by the following equation :
   (a) $u = \frac{3RT}{M}$ (b) $u = \sqrt{\frac{RT}{M}}$
   (c) $u = \sqrt{\frac{2RT}{M}}$ (d) $u = \sqrt{\frac{3RT}{M}}$

8. If λ represents the mean free path, η the viscosity and D the density of the gas under a pressure, which of the following relations is correct?

   (a) $\lambda = \eta PD$ (b) $\lambda = \frac{3}{\eta PD}$

   (c) $\lambda = \frac{3}{PD}$ (d) $\lambda = \eta\sqrt{\frac{3}{PD}}$

9. Two objects are in thermal equilibrium when they have the same

   (a) kinetic energy (b) potential energy
   (c) temperature (d) thermal energy

10. A substance which is above its critical temperature is

    (a) a gas at any pressure
    (b) boiling
    (c) can be liquefied only by application of pressure
    (d) ready to explode

11. Absolute zero may be regarded as that temperature at which

    (a) all gases become liquids
    (b) all substances are solids
    (c) molecular motion in a gas would cease
    (d) water freezes

12. How many degrees of freedom does a butterfly moving in air possess ?

    (a) 1 (b) 2 (c) 3 (d) depends on the type of motion

13. Isotherms of CO_2 drawn from Andrew's experiment show that

    (a) CO_2 has a low viscosity
    (b) CO_2 is an ideal gas
    (c) CO_2 has higher thermal conductivity
    (d) there is a continuity of states

14. Mean free path λ and molecular diameter d are related as

    (a) $\lambda \propto d^{1/2}$ (b) $\lambda \propto d^2$
    (c) $\lambda \propto d^{-1/2}$ (d) $\lambda \propto d^{-2}$

15. A pressure cooker reduces cooking time because

    (a) a large flame is used
    (b) the boiling point of water is elevated
    (c) the higher pressure tenderizes the food
    (d) the heat is more evenly distributed.

16. To cool a cup of coffee, a cold spoon can be placed in it. A spoon of which of the following metals would be most effective for this purpose assuming the spoons to have the same masses ?
    (a) Aluminium (b) Copper
    (c) Iron (d) Silver

17. A gas tends to expand indefinitely into a vacuum or into another gas. This ability is referred to as
    (a) viscosity (b) compressibility
    (c) terbulence (d) diffusion

18. Gases may be described in all except one of the following ways :
    (a) they diffuse readily (b) they are highly compressible
    (c) they possess mass (d) they are immiscible

2

MOLE

1. What is the mass of 1.5 mole of oxygen moleclues?
   (a) 16 g (b) 24 g
   (c) 32 g (d) 48 g

2. When an excess of dry chlorine was passed over 1.12 g of heated iron, 3.25 g of a chloride of iron was obtained. What is the empirical Formula of the chloride?
   (a) $Fe_3\,Cl$ (b) $Fe\,Cl_2$
   (c) $Fe\,Cl_3$ (d) $Fe_2\,Cl_6$

3. Which one of the following statements about Avagadro's law and its applications is correct ?
   (a) Equal volumes of neon and nitrogen contain the same number of atoms at S.T.P.
   (b) Equal volumes of neon and nitrogen contain the same number of molecules at S.T.P.
   (c) Equal masses of neon and nitrogen contain the same number of molecules
   (d) Equal masses of neon and nitrogen have the same volume at S.T.P.

4. 1.0 g of metal is allowed to react completely with water to produce hydrogen. Which of the following metals would give the largest volume of hydrogen in this reaction

under given conditions ?

(a) Calcium (b) Potassium
(c) Sodium (d) Strontium

5. Which one of the following statements about a gas with the empirical formula NO_2 must be correct ?

(a) Its relative molecular mass is 46.
(b) It contains approximately 30% by mass of nitrogen.
(c) One mole of gas contains 3 mol of atoms.
(d) The mass of 22.4 litres of the gas at S.T.P. is 46g.

6. One gram of mass is equal to

(a) 5×10^{10}ergs (b) 9×10^{20}ergs
(c) 7×10^{15}ergs (d) 4×10^{7}ergs

7. The ratio of number of atoms in 12 g of C and 16g of oxygen is

(a) 12/16 (b) 7
(c) 16/12 (d) 2

8. What is the number of atoms in 224 dm^3 (litre) of chlorine gas at S.T.P. ?

(a) 10 (b) 20
(c) 6.0×10^{24} (d) 1.2×10^{25}

9. Which of the following quantities of substance contains the largest number of atoms ?

(a) 0.5 mol of sulphur dioxide
(b) 16 g of oxygen
(c) 18 cm^3 of water at room temperature
(d) 44.8 dm^3 (litre) of neon at S.T.P.

10. If 40 litre of CO react completely to form CO_2, how many litres of oxygen, measured at the same temprature and pressure would be used ?

(a) 10 litres (b) 20 litres
(c) 16 litres (d) 32 litres

3

THERMOCHEMISTRY AND THERMO-DYNAMICS

1. The net work accomplished by an engine undergoing adiabatic compression is equal to

(a) $\triangle E$ (b) $-\triangle E$
(c) $-\triangle Q$ (d) $\triangle Q$

2. An engine which operates with 100 percent efficiency
   (a) is a Carnot engine
   (b) has an Otto cycle
   (c) violates the first law of thermodynamics
   (d) violates the second law of thermodynamics
3. If a heat engine absorbs heat at 600° K and rejects heat at 200° K its efficiency is
   (a) 33% (b) 50%
   (c) 67% (d) 80%
4. Which of the following equations expresses the first law of thermodynamics ?
   (a) $Q = \triangle E - W$ (b) $\triangle E = Q - W$
   (c) $\triangle E = Q + W$ (d) $\triangle E = Q + P\triangle V$
5. Out of ice, liquid water and water vapours which will have the maximum entropy ?
   (a) Ice (b) Liquid water
   (c) Vapours and liquid water both
   (d) Water vapours
6. A process can be termed spontaneous if
   (a) $\triangle G$ is positive (b) $\triangle G$ is negative
   (c) $\triangle G$ is zero
   (d) $\triangle G$ is zero in the beginning and positive at the end of the reaction
7. At the equilibrium point in a reversible reaction
   (a) $\triangle H = T\triangle S$ (b) $\triangle H < T\triangle S$
   (c) $\triangle H > T\triangle S$ (d) None of the above
8. In a typical refrigerator, heat is extracted from the interior by the
   (a) condenser (b) compressor
   (c) evaporator (d) throttling value
9. Ice melts at 273° K and enthalpy of fusion of ice is 6025 J $mole^{-1}$. The entropy of fusion of ice is
   (a) 44.14 JK^{-1} $mole^{-1}$ (b) 66.21 JK^{-1} mol^{-1}
   (c) 22.07 JC^{-1} mol^{-1} (d) 11.03 JK^{-1} mol^{-1}
10. Which of the following is not correct ?
    (a) $\triangle G$ is zero for a reversible process
    (b) $\triangle G$ is positive for a spontaneous reaction
    (c) $\triangle H$ is positive for a spontaneous reaction
    (d) $\triangle S$ increases for a spontaneous reaction
11. Of the following reactions, the one with the highest heat of reaction is
    (a) $2Na + I_2 \longrightarrow 2NaI$
    (b) $2K + Br_2 \longrightarrow 2KBr$

(c) $Li + Cl_2 \longrightarrow 2LiCl$
(d) $2Cs + F_2 \longrightarrow 2CsF$

12. The heat of neutralization of strong acid and weak base is
(a) 13.6 K cal (b) less than 13.6 K cal
(c) more than 13.6 K cal (d) none of the above

13. which among the following dissolves in water with evolution of heat ?
(a) $CoCl_2 .6H_2O$ (b) KNO_3
(c) $Na_2SO_4. 10H_2O$ (d) $CuSO_4$

14. During an isothermal expansion of an ideal gas, its
(a) enthalpy decreases
(b) enthalpy remains unaffected
(c) enthalpy reduces to zero
(d) internal energy decreases

15. Berthelot's bomb calorimeter is used to determine
(a) internal energy at constant pressure
(b) internal energy at constant volume
(c) internal energy at constant temperature
(d) entropy

16. Which one of the following is an endothermic reaction ?
(a) $2H_2+O_2 \rightarrow 2H_2O$
(b) $N_2 + O_2 \rightarrow 2NO$
(c) $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$
(d) $3O_2 + C_2H_5OH \rightarrow 2CO_2 + 3H_2O$

17. An endothermic reaction is one in which
(a) heat is absorbed
(b) heat is evolved
(c) heat is converted into mechanical work
(d) heat is converted into electricity

18. Which one of the following processes is not spontaneous ?
(a) Dissolution of salt in water
(b) Evaporation of alcohol
(c) Expansion of gas into vacuum
(d) Passage of a gas from low pressure to high pressure

19. An exothermic reaction is one which
(a) takes place only on heating
(b) is accompanied by a flame
(c) is accompanied by absorption of heat
(d) is accompanied by evolution of heat

20. In an isothermal reversible expansion of ideal gas, work done is
(a) $nRT \ln (V_2/V_1)$ (b) zero
(c) greater than zero (d) PV

21. On lowering the temperature of the sink, the efficiency of the engine
    (a) decreases
    (b) remains unchanged
    (c) increases
    (d) may increase or decrease depending upon the nature of the working substance.

22. If the temperature of the source and sink are increased by same amount, the efficiency of the engine
    (a) decreases (b) increases
    (c) may increase or decrease
    (d) remains unchanged

23. Which one of the following equations represents the reaction to which enthalpy of combustion of butane relates ?
    (a) $C_4H_{10(g)} + 9/2\ O_{2(g)} \rightarrow 4CO_{(g)} + 5H_2O_{(g)}$
    (b) $C_4H_{10(g)} + 9/2\ O_{2(g)} \rightarrow 4CO_{(g)} + 5H_2O_{(l)}$
    (c) $C_4H_{10(g)} + 13/2\ O_{2(g)} \rightarrow 4CO_{2(g)} + 5H_2O_{(g)}$
    (d) $C_4H_{10(g)} + 13/2\ O_{2(g)} \rightarrow 4CO_{2(g)} + 5H_2O_{(l)}$

24. Which one of the following equations represents the change to which the bond dissociation energy of H—Cl relates ?
    (a) $HCl_{(g)} \rightarrow \frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)}$
    (b) $HCl_{(g)} \rightarrow H_{(g)} + Cl_{(g)}$
    (c) $HCl_{(g)} \rightarrow H^+_{(g)} + Cl^-_{(g)}$
    (d) $HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(g)}$

25. For which one of the processes represented by the following equations is the enthalpy change likely to be negative ?
    (a) $Cl^-_{(g)} + aq \rightarrow Cl^-_{(aq)}$
    (b) $Cl_{(g)} \rightarrow Cl^+_{(g)} + e^-$
    (c) $\frac{1}{2}Cl_{2(g)} \rightarrow Cl_{(g)}$
    (d) $Cl_{2(l)} \rightarrow Cl_{2(g)}$

26. If $S + O_2 \rightarrow SO_2$ $\Delta H = -298.2$
    $SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$ $\Delta H = -98.7$
    $SO_3 + H_2O \rightarrow H_2SO_4$ $\Delta H = -130.2$
    $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ $\Delta H = -287.3$
    then the enthalpy of formation of
    H_2SO_4 at 298K will be
    (a) −754.4 KJ (b) −650.3KJ
    (c) +320.5 KJ (d) −433.7 KJ

27. At constant T and P, which one of the following statements is correct for the reaction ?

$$CO_{(g)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{2(g)}$$

(a) $\Delta H = \Delta E$
(b) $\Delta H < \Delta E$
(c) $\Delta H > \Delta E$
(d) ΔH is independent for the physical state of reactants

28. The energy of molecular motion is manifested as
(a) potential energy (b) heat
(c) chemical energy (d) friction

29. In order for a vapour to condense into a liquid
(a) its temperature must drop
(b) its temperature must rise
(c) it must give off heat
(d) it must absorb heat

30. Heat is most closely related to
(a) temperature (b) energy
(c) momentum (d) friction

4

SOLUTIONS

1. When 10^{-8} mole of HCl is dissolved in one litre of water, the pH of the solution will be
(a) 8 (b) 7 (c) below 7 (d) above 8

2. A pH value of 7 signifies
(a) acidic solution (b) basic solution
(c) neutral solution (d) pure water

3. When 100 ml of 1 M NaOH and 10ml of 10M H_2SO_4 solution are mixed together the resulting solution will be
(a) alkaline (b) acidic
(c) neutral (d) strongly acidic

4. For preparing one litre N/10 solution of sulphuric acid we need sulphuric acid
(a) 98 g (b) 10 g
(c) 1000 g (d) 4.9 g

5. The pH of a 0.01 M KOH solution would nearly be
(a) 0.01 (b) 12 (c) 2 (d) 14

6. The pH of N/1000 HCl would be
(a) 1.5 (b) 2.5 (c) 2 (d) 3

7. In a titration 100 ml of IN.H_2SO_4 were mixed with 100 ml of 1 M. Na OH, the resultant solution will be
(a) acidic (b) basic
(c) neutral (d) slightly acidic

8. 100 ml of 0.3 N HCl is mixed with 200 ml of 0.6N.H_2SO_4. The final normality of the resulting solution will be
(a) 0.1N (b) 0.2N (c) 0.3N (d) 0.5N.

9. What is the normality of a 1 M solution of H_3PO_4 ?
(a) 0.5N (b) 1N (c) 2N (d) 3N

10. The concentration term which changes with temperature is
(a) molality (b) molarity
(c) mole fraction (d) none of the above

11. Which solution is more concentrated ?
(a) 1 M (b) 1 m (c) 0.1M (d) 0.1m

12. The solution in which the blood cells retain their normal form are with regard to the blood
(a) hypertonic (b) hypotonic
(c) isotonic (d) equinormal

13. The molality of a solution is defined as the number of
(a) grams of solute per litre of solution
(b) moles of solute per litre of solution
(c) moles of solute per kilogram of solution
(d) moles of solute per kilogram of solvent.

14. A plant cell shrinks when kept in
(a) water
(b) a solution isotonic with the cell sap
(c) a hypertonic solution
(d) a hypotonic solution

15. Which of the following statements is true ?
(a) Molality of a solution is the number of moles of solute dissolved per litre
(b) An ideal solution obeys Raoults' law
(c) The vapour pressure of a liquid increases when some solute is added in it.
(d) Osmotic pressure does not depend upon the amount of solute dissolved.

16. Isotonic solutions must have the same
(a) critical temperature (b) density
(c) molar concentration (d) normality

17. The most strongly polar liquid is
    (a) water (b) alcohol
    (c) hydrochloric acid (d) gasoline

18. A saturated solution is a solution that
    (a) contains the maximum amount of solute
    (b) contains the maximum amount of solvent
    (c) is in process of crystallising
    (d) contains polar molecules

19. Pure water is not
    (a) polar
    (b) a good solvent
    (c) a compound
    (d) saturated

20. Ionic solids dissolve in liquids that are
    (a) polar (b) non-polar
    (c) saturated (d) supersaturated

5

DILUTE SOLUTIONS

1. The molarity of a solution prepared by adding 7.1g of Na_2SO_4 (formula mass = 142 amu) to enough water to make 100ml of solution is
   (a) 2.0M (b) 0.50M
   (c) 0.050M (d) 0.020M

2. The freezing point of a 0.050 m solution of a non-electrolyte in water is
   (a) −1.86°C (b) —0.93°C
   (c) −0.093°C (d) 0.93°C

3. One would except a high hydration energy of an ion with
   (a) high charge and small radius
   (b) high charge and large radius
   (c) low charge and small radius
   (d) low charge and large radius

4. According to Lewis definition, an acid is
(a) a proton donor (b) a proton acceptor
(c) an electron-pair donor (d) an electron-pair acceptor

5. Which of the following exhibits the greatest freezing point lowering ?
(a) 0.1 m NaCl (b) 0.1 m $CaCl_2$
(c) 0.1 m $HC_2H_3O_2$ (d) 0.1 $NaC_2H_3O_2$

6. Which of the following exhibits the smallest freezing point lowering ?
(a) 0.1 m NaCl (b) 0.1 m $CaCl_2$
(c) 0.1 m $HC_2H_3O_2$ (d) 0.1 $NaC_2H_3O_2$

7. If 250 ml of 0.250M NaCl are diluted with water to a volume of 500 ml, the new concentration of the solution is
(a) 0.167M (b) 0.125M
(c) 0.0833M (d) 0.0167M

8. 150 ml of 1.75 M $CaCl_2$ are added to 200 ml of 2.25M $CaCl_2$. Assuming that the volumes are additive, the final concentration is
(a) 2.04M (b) 1.96M
(c) 1.58 M (d) 0.680M

9. 250 ml of 0.300 M $CaCl_2$ are diluted with water until the volume is 500ml. The final concentration of Cl^- ions is
(a) 0.600 M (b) 0.300 M
(c) 0.150 M (d) 0.100 M

10. 200 ml of 1.40M Na_2SO_4 are mixed with 100 ml of 1.80 m NaCl. Assuming that the volumes are additive the final concentration of Na^+ ions is
(a) 1.53 M (b) 2.13 M
(c) 2.47 M (d) 7.40 M

11. 75ml of 0.20 HCl will neutralize how many millilitres of 0.100 M $Ba(OH)_2$?
(a) 300 ml (b) 150 ml
(c) 75ml (d) 38ml

12. $Cr_2O_7^{-2}$ will oxidise Fe^{2+} to form Cr^{+3} and Fe^{+3}. How many millilitres of 0.100M $K_2Cr_2O_7$ are required to oxidize 35.0 ml of 0.500 M $FeSO_4$ in acidic solution ?
(a) 7.00 (b) 29.2
(c) 42.0 (d) 175

13. All form ideal solutions except
(a) C_2H_5Br and C_2H_5I (b) C_6H_6 and $C_6H_5CH_3$
(c) C_6H_5Cl and C_6H_5Br (d) C_6H_5 I and C_2H_5OH

14. A solution of 1.25g of a non-electrotyte in 20g of water freezes at 271.94 k, If $k_f = 1.86$ K/m then the molecular weight of solute will be
    (a) 207.8 g/mol (b) 179.79 g/mol
    (c) 209.6 g/mol (d) 109.6 g/mol

15. The freezing point of a substance is always lower than its
    (a) melting point
    (b) boiling point
    (c) specific heat
    (d) heat of vaporisation.

6

IONIC EQUILIBRIA

1. The following substances may be added to one litre of water to prepare a buffer
   (a) one mole of $HC_2H_3O_2$ and one mole of HCl
   (b) one mole of NH_4OH and one mole of NaOH
   (c) one mole of NH_4Cl and one mole of HCl
   (d) one mole of $HC_2H_3O_2$ and 0.5 mole of NaOH

2. Adding sodium hydroxide to a solution of acetic acid
   (a) increases $[C_2H_3O_2]^-$ (b) increases $[H^+]$
   (c) increases $[HC_2H_3O_2]$ (d) decreases the pH

3. The following substance undergoes hydrolysis in aqueous solution
   (a) HCl (b) $HC_2H_3O_2$
   (c) NH_4OH (d) NH_4Cl

4. The pH of a solution whose hydrogen ion concentration is 0.0010M is
   (a) 3.0 (b) 5.0
   (c) 9.0 (d) 11.0

5. Using only the periodic table choose the strongest acid
   (a) H_3PO_4 (b) H_3PO_3
   (c) H_3AsO_3 (d) H_3AsO_4

6. Which of the following has the lowest concentration of H^+ ?
(a) 0.2M HNO_3
(b) 0.2M HCl
(c) 0.2M $HC_2H_3O_2$
(d) 0.2M $NaC_2H_3O_2$

7. Which of the following has the highest pH ?
(a) 0.1M NaOH
(b) 0.1M $NaC_2H_3O_2$
(c) 0.1M NH_4OH
(d) 0.1M C_2H_5OH

8. Which of the following has the largest dissociation constant ?
(a) NH_4OH
(b) HNO_3
(c) $HC_2H_3O_2$
(d) H_2O

9. Which of the following is least soluble ?
(a) Ni S (Ks.p.$=3 \times 10^{-21}$)
(b) Pt S (Ks.p.$=8 \times 10^{-73}$)
(c) Mn S (Ks p.$=7 \times 10^{-16}$)
(d) Fe S (Ks.p.$=4 \times 10^{-19}$)

10. Which of the following is most soluble ?
(a) Cu S (Ks.p.$=8 \times 10^{-37}$)
(b) Ag_2 S (Ks.p.$=6 \times 10^{-51}$)
(c) Bi_2 S_3 (Ks.p.$=1 \times 10^{-70}$)
(d) Mn S (Ks.p.$=7 \times 10^{-16}$)

11. The solubility of Sr SO_4 (Ks.p.$=7.6 \times 10^{-7}$) is
(a) 8.7×10^{-4}M
(b) 7.6×10^{-7}M
(c) 8.7×10^{-8}M
(d) 2.8×10^{-4}M

12. Solution prepared by dissolving equal number of moles of HOCl ($K_{dis} = 3.2 \times 10^{-8}$) and NaOCl is a buffer for pH of
(a) 8.0
(b) 7.5
(c) 3.2
(d) 4.8

13. The following solubility products were determined experimentally; which of the compounds has the lowest solubility in moles/litre ?
(a) Ag Cl 1.56×10^{-10}
(b) Ag Br 7.7×10^{-12}
(c) Ag CNS 1.2×10^{-12}
(d) Ag_2 CrO_4 2.4×10^{-12}

14. According to Lewis concept, an acid is a substance which
(a) accepts proton
(b) accepts a lone pair of electrons
(c) donates a proton
(d) donates a lone pair of electrons

15. The following substances may be added to one litre of water to prepare a buffer
    (a) one mole of $HC_2H_3O_2$ and one mole of HCl
    (b) one mole of NH_4OH and one mole of NaOH
    (c) one mole of NH_4Cl and one mole of HCl
    (d) one mole of $HC_2H_3O_2$ and 0.5 mole of NaOH

16. Using only the periodic table choose the strongest acid
    (a) H_3PO_3 (b) H_3PO_4
    (c) H_3AsO_3 (d) H_3AsO_4

17. Mixing 0.10 mole of NaOH and 0.10 mole of $HC_2H_3O_2$ and one litre of water yields a solution which is
    (a) acidic (b) neutral
    (c) basic (d) red.

18. The following substance undergoes hydrolysis in aqueous solution
    (a) HCl (b) $HC_2H_3O_2$ (c) NH_4OH (d) NH_4Cl

19. Hydrolysis of oxide ion in water produces
    (a) H_2O (b) H^+ (c) OH^- (d) O_2

20. If it were possible to take one mole of S^{+6} ions and add them to one litre of water, the resulting solution would be
    (a) strongly acidic (b) strongly basic
    (c) slightly acidic (d) slightly basic

21. The structure of hydrated aluminium ion is thought to be
    (a) square (b) tetrahedral
    (c) octahedral (d) spherical

22. If the ionic product, of a dissolved salt exceeds its solubility product, the solution must be
    (a) saturated (b) unsaturated
    (c) super saturated (d) hot

23. The number of syllables in the word *dissociation* is
    (a) 5 (b) 6 (c) 7 (d) 8

24. A solution of Na_2CO_3 in the water turns
    (a) phenolphthalein pink
    (b) methyl orange red
    (c) methyl orange yellow
    (d) blue litmus red.

25. An halide ion is an extremely
    (a) weak acid (b) strong acid
    (c) weak base (d) strong base

26. Which of the following is not a hydrolysis reaction ?
    (a) $N_2H_5^+ + H_2O \rightleftharpoons N_2H_5OH + H^+$
    (b) $CN^- + H_2O \rightleftharpoons HCN + OH^-$
    (c) $Fe^{+3} + H_2O \rightleftharpoons [Fe(OH)]^{2+} + H^+$
    (d) $Na_2O + H_2O \rightleftharpoons 2Na^+ + 2OH^-$

27. Of the following, the best conductor is
    (a) water
    (b) a solution of sugar in water
    (c) a water solution of hydrogen chloride
    (d) liquefied hydrogen chloride.

28. A conductivity cell is platinised
    (a) to avoid polarisation effect
    (b) to avoid capacitance of the cell
    (c) to avoid temperature effects
    (d) to prolong its effect.

29. The equivalent conductance of an electrolyte increases as
    (a) dilution decreases (b) dilution increases
    (c) temperature decreases (d) cell constant increases

30. Which of the following is Lewis acid ?
    (a) $BaCl_2$ (b) NaCl (c) CCl_4 (d) $AlCl_3$

31. When Lewis acid and Lewis base react together
    (a) a covalent bond is formed
    (b) an ionic bond is formed
    (c) a hydrogen bond is formed
    (d) a coordinate covalent bond is formed

32. Which of the following salts undergoes hydrolysis ?
    (a) CH_3COONa (b) KNO_3
    (c) NaCl (d) K_2SO_4

33. Which of the following will happen when a blue litmus paper is dipped in freshly prepared solution of chlorine water ?
    (a) The paper turns red
    (b) The paper becomes white
    (e) The paper remains blue
    (d) The paper dissolves

34. Sodium chloride easily dissolves in water; this is because
    (a) it is an electrovalent compound
    (b) it is a salt of sodium metal
    (c) its ions are easily solvated
    (d) salt reacts with water.

35. Which of the following is not soluble in water ?
    (a) Sodium sulphate (b) Barium sulphate
    (c) Zinc sulphate (d) Calcium sulphate

36. Which of the following is the strongest acid ?
(a) CH_3 COOH (b) H_3PO_4
(c) H_2SO_4 (d) HNO_3

37. When a solid electrolyte is dissolved in water there is
(a) increase in attractive forces between the ions
(b) decrease in attractive forces between the ions
(c) electron transfer
(d) decrease in electrical conductivity of water

38. Which of the following will conduct electricity best ?
(a) A solution of CH_3COONa in water
(b) A solution of CH_3COOH in water
(c) A solution of sugar in water
(d) A colloidal solution of starch in water

39. A solution of which of the following will give a precipitate with a solution of lead nitrate but not with a solution of barium nitrate ?
(a) Sodium chloride (b) Sodium carbonate
(c) Sodium sulphate
(d) Sodium hydrogen phosphate.

40. The dissociation of an electrolyte can be suppressed by introducing an ion common with that of the electrolyte this common ion effect could be used for
(a) precipitating a dissolved substance
(b) hydrolysis of the electrolyte
(c) controlling the pH of solutions
(d) finding out the solubility product

41. The reason that acids in the liquid state are not dissociated is that their chemical bonds are
(a) ionic (b) covalent
(c) metallic (d) van der Waals

42. A strong acid or base in solution is completly
(a) ionised (b) neutralised
(c) hydrolysed (d) precipitated

43. Dissociation refers to
(a) the formation of a ppt
(b) the separation of a mixture of polar and non-polar liquids (such as oil and water) into separate layers
(c) the separation of a solution containing ions into separate layers of + ve and − ve ions
(d) the separation of a substance into free ions

44. Neutralisation occurs during
(a) electrolysis (b) precipitation
(c) ionisation
(d) solution of a non-electrolyte

45. A strong acid or base in solution is completely
    (a) ionised (b) neutralised
    (c) hydrolysed (d) precipitated
46. Water is formed during
    (a) hydrolysis (b) electrolysis
    (c) neutralisation (d) crystallisation
47. Pure water contains
    (a) only H^+ (b) only OH^- ions
    (c) both H^+ and OH^- ions
    (d) neither H^+ nor OH^- ions
48. The symbol of the hydronium ion is
    (a) H^+ (b) H_2O (c) H_3O^+ (d) $H_5O_2^+$

7

CHEMICAL KINETICS AND PHOTO-CHEMISTY

1. The rate constant of a reaction depends upon
   (a) initial concentration of reactants
   (b) extent of reaction
   (c) temperature
   (d) time of reaction
2. The kinetic equation for the first order is
   (a) $k = \frac{2.303}{t} \log \frac{a}{a-x}$
   (b) $k = \frac{2.303}{t} \log \frac{a-x}{a}$
   (c) $k = \frac{2.303}{t} \log \frac{a}{a-x}$
   (d) $k = \frac{2.303}{t} \times \frac{a}{a-x}$
3. Which of the following factors does not influence the rate of a reaction ?
   (a) Concentration of reactants

(b) Nature of reactants
(c) Molecularity of the reaction
(d) Temperature

4. The mechanism of a reaction can sometimes be deduced from

(a) the temperature dependence of the rate
(b) the rate law
(c) the net equation
(d) the activation energy.

5. The activation energy of a reaction may be lowered by

(a) raising the temperature
(b) lowering the temperature
(c) removing the products of the reaction
(d) adding a catalyst

6. The equilibrium constant in a reversible chemical reaction at given temperature

(a) depends on the initial concentrations of the reactants
(b) depends on the concentration of one of the products at equilibrium
(c) does not depend on the initial concentrations
(d) is not characteristic of the reaction

Answer the following questions 7–9 with the help of the hypothetical reaction and its rate law

$$3A_{(g)} + B_{(g)} + 2C_{(g)} \rightarrow D_{(g)} + 2E_{(g)}$$

Rate of formation of $D = k[A][B]^2$

7. Doubling of the concentration of A increases the rate of reaction by a factor of

(a) 2 (b) 3 (c) 4 (d) 9

8. Doubling the concentration of B increases the rate of the reaction by a factor of

(a) 2 (b) 3 (c) 4 (d) 9

9 If the volume of the container is suddenly reduced to one-half its original volume the rate will increase by a factor of

(a) 2 (b) 4 (c) 8 (d) 16

10. The value of k, the specific rate constant, may be increased by

(a) decreasing the concentration of D
(b) increasing the concentration of A
(c) increasing the concentration of C
(d) increasing the temperature

11. What effect does an increase in temperature of 10°C have on the rate of the reaction ?
    (a) Halved (b) Multiplied by 1.5
    (c) Doubled (d) Tripled

12. Which of the following is the best explanation for the effect of increase in temperature on the rate of the reaction ?
    (a) It increases the number of particles with the necessary activation energy
    (b) It enables the reacting particles with the necessary activation energy
    (c) It lowers the activation energy for the reaction
    (d) It enables the activated complex to be more easily converted to the products.

13. The reactions of high molecularity are rare because
    (a) activation energy of many body collisions is very high
    (b) many body collisions have a low probability
    (c) many body collisions are not favoured energetically
    (d) none of the above statements is true

14. At 25°C, the half-life for the decomposition of N_2O_5 is 5.7 hours, and is independent of the initial pressure of N_2O_5 the specific rate constant is
    (a) ln 2 (b) $(1/5.7)\text{hr}^{-1}$
    (c) $(\ln 2/5.7)^{-1}\text{hr}^{-1}$ (d) $(\ln 2/5.7)\text{hr}$

15. If the rate of the reaction is independent of the concentration of the reactant, the reaction is of
    (a) zero order (b) first order
    (c) second order (d) third order

16. Who among the following gave the law of photochemical equivalence ?
    (a) Drapper (b) Einstein
    (c) Grotthus (d) Lambert

17. The energy of electromagnetic radiation depends on
    (a) its amplitude (b) its frequency
    (c) its wave length (d) none of the above

18. What term is used to define the phenomenon of emission of light in a chemical reaction ?
    (a) Chemical luminescence
    (b) Photosensitisation
    (c) Both chemical luminescence and photosensitisation
    (d) None of the above

19. Raman spectra may be obtained in
    (a) IR and visible region

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(b) visible region only
(b) IR and micro wave region
(d) UV and visible region

20. ESR spectra mainly helps in study of

(a) compounds having hydrogen
(b) compounds having carbon
(c) free radicals
(d) ionic compounds

21. Which one of the following rate laws has an overall order of 0.5 for the reactions involving substances X, Y, Z. ?

(a) Rate $= k(Cx)(Cy)(Cz)$
(b) Rate $= k(Cx)^{0.5}(Cy)^{0.5}(Cz)^{0.5}$
(c) Rate $= k(Cx)^{1.5}(Cy)^{-1}(Cz)^{0}$
(d) Rate $= k(Cx)(Cz)^{0}/(Cy)^{2}$

22. Chemical reaction rates in solution do not depend to any great extent upon

(a) pressure (b) temperature
(c) concentration (d) catalyst

8

EQUILIBRIUM AND CATALYSIS

1. Given the equilibrium

$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2\,(g)}$ $\Delta H = +22K$ cal

the concentration of Cl_2 at equalibrium will be increased by

(a) lowering of temperature
(b) adding PCl_3 to the mixture
(c) adding PCl_5 to the mixture
(d) increasing the pressure

2. In which of the following cases does the reaction go farthest to completion ?

(a) $K = 10^2$ (b) $K = 10^{-2}$
(c) $K = 10$ (d) $K = 1$

3. For the reaction $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$, the equilibrium constant K changes with
   (a) catalyst (b) total amount of H_2 and I_2
   (c) temperature (d) total pressure

4. H_3PO_4 retards the decomposition of H_2O_2, therefore it is a
   (a) auto catalyst (b) negative catalyst
   (c) positive catalyst (d) poison

5. Which of the following substances is used as a promoter in the Haber's process ?
   (a) Ni (b) Mo (c) W (d) Cr

6. $CaCO_{3(s)}$ and $CaO_{(s)}$ and $CO_{2(g)}$ are placed in a box and are allowed to reach equilibrium
   $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$ $\Delta H = +43$K cal
   The mass of CaO in the box would be increased by
   (a) adding more $CaCO_3$
   (b) lowering the temperature
   (c) removing some CO_2
   (d) reducing the volume of the box

Question 7–11 refer to the following equilibrium

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} \quad \Delta H = -45\text{K cal}$$

7. The number of moles of O_2 at equilibrium will decrease if
   (a) a catalyst is added
   (b) an inert gas is added to the system
   (c) O_2 is added to the system
   (d) SO_3 is removed from the system

8. The number of moles of SO_2 at equilibrium will increase if
   (a) temperature of the system is lowered
   (b) the volume of container is increased
   (c) O_2 is added to the system
   (d) SO_2 is removed from the system

9. The concentration of SO_2 at equilibrium will increase if
   (a) temperature of the system is lowered
   (b) the volume of container is increased
   (c) O_2 is added to the system
   (d) SO_2 is removed from the system

10. The concentration of SO_3 at equilibrium will increase if
   (a) the temperature of the system is lowered
   (b) the volume of the container is increased
   (c) SO_2 is removed from the system
   (d) an inert gas is added to the system

11. The concentration of O_2 at equilibrium will increase if
    (a) SO_2 is added to the system
    (b) SO_3 is added to the system
    (c) the temperature of the system is lowered
    (d) an inert gas is added to the system.
12. 1.20 g of urea are present in 5 litre solution. The active mass of urea will be
    (a) 0.2 (b) 0.06
    (c) 0.4 (d) 0.08
13. In which of these processes is platinum used as a catalyst?
    (a) Oxidation of ammonia to form nitric acid
    (b) Hardening of oil
    (c) Production of synthetic rubber
    (d) Synthesis of menthol.
14. Which of the following equations is correct ?
    (a) $K_p = K_c (\triangle v)$ (b) $K_p = T. C_v$
    (c) $K_p = K_c (\triangle n)$ (d) $K_p = K_c (RT)^{\triangle n}$
15. Which one of the following reactions involves thermal dissociation ?
    (a) $H_2 + Cl_2 \rightarrow 2\,HCl$
    (b) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$
    (c) $2\,Mg + O_2 \rightarrow 2\,MgO$
    (d) $2\,Pb\,(NO_3)_2 \rightarrow 2\,PbO + 4\,NO_2 + O_2$
16. If the value of the equilibrium constant for
    $A_{(g)} + 2B_{(l)} \rightleftharpoons 4C_{(g)}$
    is 0.123, then the value of the equilibrium constant for
    $4\,C_{(g)} \rightleftharpoons A_{(g)} + 2B_{(l)}$
    is
    (a) 0.123 (b) —0.123 (c) 6.47 (d) 8.13
17. If the equilibrium constant for
    $A_{(g)} + 2B_{(g)} \rightleftharpoons 3C_{(g)}$ is 2.25,
    then the concentration of A in equilibrium with 2.00 moles per litre of B and 3.00 moles per litre of C is
    (a) 1.00 mole/litre (b) 2.00 mole/litre
    (c) 3.00 mole/litre (d) 4.00 mole/litre
18. The equilibrium constant for
    $Ag_2S_{(s)} \rightleftharpoons 2\,Ag^+ + S^{-2}$
    is called
    (a) electrolyte constant (b) dissociation constant
    (c) rate constant (d) solubility product
19. For the system
    $A_{(g)} + B_{(g)} \rightleftharpoons C_{(g)} + D_{(g)}$

the specific rate constants are 0.16 and 4.0×10^4 for the forward and reverse reactions, respectively. If each reaction occurs in one step, the equilibrium constant is

(a) 2.5×10^4 (b) 2.5×10^5
(c) 2.5×10^{-5} (d) 2.5×10^{-6}

20. If the equilibrium constant for
$X_{(s)} + Y_{(g)} \rightleftharpoons 3Z_{(g)}$ is 0.128,
the concentration of Z in equilibrium with Y at a concentration of 0.50 mole/litre is
(a) 0.064 mole/litre (b) 0.40 mole/litre
(c) 0.25 mole/litre (d) 1.50 mole/litre

21. If the solubility of AB is 0.10 mole/litre, the solubility product for
$AB_{(s)} \rightleftharpoons A^+ + B^-$
is
(a) 1.0×10^2 (b) 1.0×10^{-2}
(c) 1.0×10^4 (d) 1.0×10^{-4}

22. In the system
$AB_{(s)} \rightleftharpoons A^+ + B^-$
doubling the equilibrium concentration of A^+ will cause the equilibrium concentration of B^- to change to
(a) 2 times its original volume
(b) 1/2 of its original volume
(c) 1/3 of its original volume
(d) 1/4 of Its original volume

23. The conjugate base of NH_4^+ is
(a) NH_3 (b) NH_4OH (c) KOH (d) OH^-

24. Le Chatelier's principle applies
(a) only to reactions among gases
(b) to all chemical reactions
(c) to all systems at equilibrium
(d) to all physical equilibria

25. During the thermal dissociation of a gas the vapour density
(a) decreases
(b) increases
(c) increases in some cases and decreases in other
(d) remains constant

26. In the presence of a catalyst, the heat evolved or absorbed in a reaction
(a) decreases (b) increases
(c) remains unaffected (d) none of the above

27. The quantitative relationship between reaction rate and concentration was established experimentally in 1867 by

(a) Faraday (b) Guldberg and Waage
(c) Le Chatelier (d) Arrhenius

28. Solubility of a substance which dissolves with a decrease in volume and absorption of heat will be favoured by

(a) high pressure and high temperature
(b) low pressure and low temperature
(c) High pressure and low temperature
(d) low pressure and high temperature

29. Which of the following metals make most efficient catalysts ?

(a) Alkali metals
(b) Alkaline earth metals
(c) Transition metals
(d) Noble gases

30. The vapour density of fully dissociated ammonium chloride would be

(a) slightly less than half of that of NH_4Cl
(b) half that of NH_4Cl
(c) double that of NH_4Cl
(d) none of these

31. For a reaction

$2A + B \rightleftharpoons C + D$

the active mass of B is kept constant and that of A is trebled. It is observed that the rate of reaction

(a) decreases three times
(b) decreases nine times
(c) increases six times
(d) increases nine times

32. At 960°C the K for

$H_{2(g)} + CO_{2(g)} \rightleftharpoons H_2O_{(g)} + CO_{(g)}$

is 1.60. If the equilibrium concentration of H_2 at 986°C is 1.0 M, that of CO_2 is 0.50 M and that of H_2O is 0.40 M, then the equilibrium concentration of CO is

(a) 0.40M (b) 0.50M (c) 1.0M (d) 2.0M

33. At 986° C the K for

$H_{2(g)} + CO_{2(g)} \rightleftharpoons H_2O_{(g)} + CO_{(g)}$

is 1.60. If 0.40 mole of H_2 and 0.40 mole of CO_2 are placed in a 1.0 litre container at 986°C, the final equilibrium concentration of water will be :

(a) 0.80 M (b) 0.25 M (c) 0.23 M (d) 0.20 M

34. Which of the following best explains the effect of a catalyst on the rate of a reversible reaction ?
    (a) It provides a new reaction path with a lower activation energy.
    (b) It moves the equilibrium position to the right
    (c) It increases the kinetic energy of the reacting molecules
    (d) It decreases the rate of the reverse reaction

35. Which one of the following descriptions of the equilibrium state reached in a reversible reaction is correct?
    (a) The rate of forward reaction has fallen to zero.
    (b) The rate of forward and reverse reactions are equal.
    (c) The reactants have been completely converted to products.
    (d) Only certain reactant molecules are capable of reacting, leaving the rest unchanged.

36. In which one of the following ways would the pH value of aqueous ammonia be affected by dissolving solid NH_4Cl in it ?
    (a) No effect
    (b) Decreases
    (c) Increases
    (d) Impossible to predict

37. The brown gas prepared by the action of concentrated nitric acid on copper is an equilibrium mixture of dinitrogen tetroxide and nitrogen dioxide

$$N_2O_{4(g)} \overset{\text{Endo}}{\rightleftharpoons} 2NO_{2(g)}$$

Which one of the following changes would result in a darkening of the colour ?
    (a) Increase in pressure
    (b) Increase in temperature
    (c) Addition of a catalyst
    (d) Removal of dinitrogen tetroxide by liquefaction

38. Fe (III) chloride reacts with KSCN in aqueous solution to give a deep red coloured complex ion

$$Fe^{+3}_{(aq)} + SCN^{-}_{(aq)} \rightleftharpoons [Fe\,(SCN)]^{2+}_{(aq)}$$

yellow colour less deep red

the addition of which one of the following would intensify the red colour ?
    (a) Ammonium thio cyanate
    (b) Iron (II) sulphate
    (c) Potassium sulphate
    (d) Sodium chloride

39. Which one of the following is an illustration of a reversible reaction ?
   (a) $Pb(NO_3)_2 + 2NaI \rightarrow PbI_2 + 2NaNO_3$
   (b) $2Na + 2HOH \rightarrow 2NaOH + H_2$
   (c) $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
   (d) $KNO_3 + NaCl \rightarrow KCl + NaNO_3$

40. The oxidation of SO_2 and O_2 to SO_3 is an exothermic reaction the yield of SO_3 will be maximum if
   (a) temperature is increased, pressure kept constant
   (b) temperature is reduced, pressure increased
   (c) temperature and pressure are both increased
   (d) temperature and pressure are both decreased

41. Which equilibrium can be described as an acid-base reaction using the Lewis acid-base definition, but not using Bronsted-Lowry definition ?
   (a) $NH_3 + CH_3COOH \rightleftharpoons CH_3COO^- + NH_4^+$
   (b) $H_2O + CH_3COOH \rightleftharpoons H_3O^+ + CH_3COO^-$
   (c) $4NH_3 + [Cu(H_2O)_4]^{2+} \rightleftharpoons [Cu(NH_3)_4]^{2+} + 4H_2O$
   (d) $2NH_3 + H_2SO_4 \rightleftharpoons 2NH_4^+ + SO_4^{-2}$

42. Given
   $HF + H_2O \xrightarrow{K_a} H_3O^+ + F^-$
   $F^- + H_2O \xrightarrow{K_b} HF + OH^-$
   Which one of the following relations is correct ?
   (a) $K_b = K_w$
   (b) $K_b = 1/K_w$
   (c) $K_a \times K_b = K_w$
   (d) $K_a/K_b = K_w$

43. For reaction
   $4A + B \rightarrow 2C + 2D$
   Which of the following statements is *not* correct ?
   (a) The rate of disappearance of B is one fourth the rate of disappearance of A.
   (b) The rate of appearance of C is one half the rate of disappearance of A.
   (c) The rate of disappearance of C is one half the rate of consumption of A.
   (d) The rate of formation of C and D are equal

44. For which of the following reactions does the equilibrium constant depend on the units of concentration ?
   (a) $NO_{(g)} \rightleftharpoons \frac{1}{2}N_{2(g)} + \frac{1}{2}O_{2(g)}$
   (b) $Zn_{(s)} + Cu^{2+}_{aq} \rightleftharpoons Cu_{(s)} + Zn^{2+}_{aq}$
   (c) $C_2H_5OH_{(l)} + CH_3COOH_{(l)} \rightleftharpoons CH_3COOC_2H_{5(l)} + H_2O_{(l)}$
   (Reaction carried out in an inert solvent)
   (d) $COCl_{2(g)} \rightleftharpoons CO_{(g)} + Cl_{2(g)}$

45. The decomposition of N_2O_4 to NO_2 is carried out at 280K in chloroform when equilibrium has been established, 0.2 mol of N_2O_4 and 2×10^{-3} mol of NO_2 are present in a 2l solution. The equilibrium constant for the reaction $N_2O_4 \rightleftharpoons 2NO_2$ is

(a) 1×10^{-2}	(b) 2×10^{-3}
(c) 1×10^{-5}	(d) 2×10^{-5}

46. Most chemical reactions are

(a) reversible	(b) irreversible
(c) exothermic	(d) endothermic

47. Le Chatelier's principle is concerned with

(a) catalysts	(b) chemical equilibrium
(c) photosynthesis	(d) activated molecules

48. At equilibrium,
(a) both forward and reverse reactions have ceased
(b) the forward and reverse reactions are proceeding at the same rate
(c) the forward reation has come to stop and the reverse reaction is just about to begin
(d) a considerable amount of heat evolved

9

ELECTROCHEMISTRY

1. Which of the following might be used as an electrode ?

(a) A stick	(b) A nail
(c) A glass rod	(d) A soda straw

2. The e.m.f. value for oxidation from H_2 at 1.0 atm to H^+ at 1.0×10^{-1} M is

(a) 0.00 V	(b) 0.059 V
(c) -0.059 V	(d) 0.030 V

3. A good reducing agent
(a) will always react rapidly
(b) has a negative oxidation potential
(c) is readily oxidized
(d) shows a negative oxidation number

4. A Faraday of electricity is
   (a) one ampere per second
   (b) 96,500 coulombs per second
   (c) 6.02×10^{23} electrons per second
   (d) 6.02×10^{23} electronic charges

5. When aqueous HCl is electrolysed
   (a) chlorine gas is produced at the anode
   (b) hydrogen gas is produced at the anode
   (c) oxygen gas is produced at the anode
   (d) oxygen gas is produced at the cathode.

6. The number of electrons necessary to produce 1.00 gm of Cu from Cu^{2+} at the cathode of an electrolytic cell is
   (a) 1.89×10^{22} (b) 3.04×10^{3}
   (c) 9.47×10^{21} (d) 1.91×10^{25}

7 A possible advantage to using the half reaction method for balancing oxidation-reduction equations is
   (a) electrons need not be balanced
   (b) oxidation numbers are not assigned
   (c) charges are not balanced
   (d) atoms need not be balanced.

8. In a galvanic cell the cathode
   (a) is always made of copper
   (b) is always made of zinc
   (c) may be made of an inert metal
   (d) always attracts negative ions in the solution.

9. Hydrogen ions are more readily reduced than
   (a) Ag^+ (b) Cu^{++}
   (c) Cl_2 (d) Zn^{++}

10. The measured oxidation potential for $Mg_{(s)} \rightleftharpoons Mg^{++} + 2e^-$ does not depend on :
    (a) the temperature
    (b) the size of the Mg electrode
    (c) the concentration of Mg^{+2}
    (d) the purity of $Mg_{(s)}$.

11. Not all galvanic cells contain
    (a) a cathode (b) an anode
    (c) a porous partition (d) ions.

12. When a cell of a lead storage battery is being charged, it is
    (a) a galvanic cell (b) an electrolytic cell
    (c) a Daniell cell (d) a dry cell.

13. A current of 9.65 ampere is drawn from a Daniell cell for exactly 1 hour. The loss of mass of anode is
(a) 0.180 g (b) 23.6 g
(c) 0.197 g (d) 11.8 g.

14. The following reaction does not occur spontaneously (all ions at 1 m concentration; all gases at 1 atmosphere pressure)
(a) $2\ Cr_{(s)} + 3\ Cl_{2(g)} \rightarrow 2\ Cr^{+3} + 6\ Cl^-$
(b) $NO_3^- + 2\ H^+ + Ag_{(s)} \rightarrow Ag^+ + H_2O + NO_{2(g)}$
(c) $NO_3^- + 4\ H^+ + 3\ Ag_{(s)} \rightarrow 3\ Ag^+ + NO_{(g)} + 2H_2O$
(d) $Cl_{2(g)} + 2\ Br^- \rightarrow 2\ Cl^- + Br_2$

15. If 0.200 litre of 0.100 M NaCl are electrolysed until the OH^- concentration is 0.0500 M, how many moles of Cl_2 gas are produced ?
(a) 5.00×10^{-3} mole (b) 1.00×10^{-2} mole
(c) 5.00×10^{-2} mole (d) 1.00×10^{-1} mole

16. As the lead storage battery is charged,
(a) the amount of sulphuric acid decreases
(b) the lead electrode becomes coated with lead sulphate
(c) sulphuric acid is regenerated
(d) lead dioxide dissolves.

17. If an aqueous solution of KI is electrolysed (with platinum electrodes) one would expect to find
(a) potassium deposited at the cathode
(b) oxygen liberated at the anode
(c) the solution around the cathode becoming alkaline
(d) the solution around the anode becoming brown.

18. When an aqueous solution of NaCl is electrolysed, a product formed at the cathode is
(a) Na (b) H^+
(c) OH^- (d) Cl_2

19. If aqueous $Cu\ SO_4$ is electrolysed for one minute with a current of 2.00 ampere, the volume of oxygen produced at STP at the anode is
(a) 3.10×10^{-4} litre (b) 6.96 ml
(c) 1.16×10^{-4} litre (d) 1.16 ml

20. As a lead storage battery is discharged
(a) water is used up
(b) lead is formed
(c) lead sulphate is consumed
(d) sulphuric acid is consumed.

21. If a large quantity of cobalt metal were dropped into a

solution containing Ag^+, Fe^{+3}, Cu^{+2}, the products of the reaction would be :

(a) Ag, Fe and Cu (b) Ag, Fe^{++} and Cu^+
(c) Fe^{++}, Cu and Co^{++} (d) Fe^{++}, Cu, Ag and Co^{++}

22. Which of the following instruments makes use of the standard electrode potentials and the variation of electrode potential with concentration ?

(a) Polarimeter (b) pH meter
(c) Electrophorous (d) Electrophotometer.

23. The series in which the electrode potentials of metals are arranged in an order is known as :

(a) electrical conductivity series
(b) electrode potential series
(c) electrochemical series
(d) chemical affinity series.

24. In a salt-bridge KCl is used because

(a) agar-agar forms a good jelly with it
(b) KCl is an electrolyte
(c) K^+ and Cl^- have the same transference number
(d) KCl is present in calomel electrode.

25. Four colourless salt solutions are placed in separate test-tubes and a strip of copper is dipped in each. Which solution finally turns blue ?

(a) $Pb(NO_3)_2$ (b) $Zn(NO_3)_2$
(c) $AgNO_3$ (d) $Cd(NO_3)_2$

26. When an electric current is passed through a cell containing an electrolyte, positive ions move towards the cathode and negative ions towards the anode. What will happen if the cathode is pulled out of solution ?

(a) The positive ions will start moving towards the anode and negative ions will stop moving
(b) The negative ions will continue to move towards the anode and the positive ions will stop moving
(c) Both negative and positive ions will move towards the anode
(d) None of these movements will take place.

27. What is the standard cell potential for the cell

Zn; Zn^{+2} (1M) || Cu^{+2} (1M); Cu

(E° for $Zn^{+2} | Zn = -0.76$; E° for $Cu^{+2} | Cu = +0.34$)

(a) $-0.76 + 0.34 = -0.42$ V
(b) $-0.34-(-0.76) = +1.10$ V
(c) $-0.34-(-0.76) = +0.42$ V
(d) $-0.76-(+0.34) = -1.10$ V.

28. One Faraday of current was passed through the electrolytic cells placed in series containing solutions of Ag^+, Ni^{+2} and Cr^{+3} respectively. The amount of Ag (At. Wt. 108), Ni (At. Wt. 59) and Cr (At. Wt. 52) deposited will be :

Silver	Nickel	Chromium
(a) 108 g	29.5 g	17.5 g
(b) 108 g	59 g	52.0 g
(c) 108 g	108 g	108 g
(d) 108 g	117.5 g	166 g

29. Given standard electrode potentials

	E°
$Fe^{++} + 2e \rightarrow Fe$	-0.440 V
$Fe^{+++} + 3e \rightarrow Fe$	-0.036 V

The standard electrode potential (E°) for

$Fe^{+++} + e \rightarrow Fe^{++}$ is

(a) -0.476 V
(b) -0.404 V
(c) $+0.404$ V
(d) $+0.771$ V

30. The magnitude of the individual half cell potentials are given

(i) $Co^{2+} + 2e \rightarrow Co$ 0.28 V
(ii) $Hg_2^{2+} + 2e \rightarrow 2\,Hg$ 0.78 V

when both the half cells (a) and (b) are connected with SHE, the metallic electrode Co is found to be $-$ve and Hg electrode is found to be $+$ ve. The correct sign for the electrode potentials will be :

(a) $+$ ve for half cell (i)
(b) $+$ ve for half cell (ii)
(c) $-$ ve for half cell (ii)

31. When an iron wire is immersed in an acidic solution of $CuSO_4$, the blue colour of the solution is lost after some time. This is due to

(a) reduction of Cu^{++}
(b) oxidation of $CuSO_4$
(c) formation of double complex between iron and copper sulphate
(d) formation of a colourless salt of Cu^{++}.

32. Magnesium cannot displace from solution the ions of

(a) sodium (b) lead
(c) copper (d) gold

10

COLLOIDS

1. The main difference between crystalloids and colloids is
   (a) concentration (b) electricial conductivity
   (c) particle size (d) particle composition
2. Which of the following is not true about colloids ?
   (a) Lyophobic sols are irreversible
   (b) Many lyophilic sols form gels
   (c) Starch is a lyophobic sol
   (d) The process of purifying a colloidal solution is called dialysis and can be carried out through parchment or cellophane
3. An emulsion is a colloidal system consisting of
   (a) one liquid and one gas
   (b) one liquid and one solid
   (c) two liquids
   (d) two solids
4. Which one of the following substances forms a positively charged sol ?
   (a) As_2S_3 (b) $Fe(OH)_3$
   (c) Gold (d) Starch
5. An aerosol is a colloidal system of
   (a) a gas dispersed in a liquid
   (b) a liquid dispersed in a gas
   (c) a liquid dispersed in a solid
   (d) a solid dispersed in a gas
6. Difference between colloids and crystalloids is of
   (a) diameter (b) particle size
   (c) radius
   (d) the first is soluble but the second is in soluble
7. Smoke is
   (a) a gas (b) a gaseous mixture
   (c) a colloidal system
   (d) a mixture of CO_2 and steam
8. Milk is
   (a) an element
   (b) a mixture of elements
   (c) a colloidal suspension
   (d) an emulsion

9. Blood contains
   (a) negatively charged particles
   (b) neutral particles
   (c) negatively as well as positively charged particles
   (d) positively charged particles.

10. Blood cells retain their normal shape in solutions which are
    (a) isotonic to blood
    (b) hypertonic to blood
    (c) equinormal to blood
    (d) isochoric to blood

11. Colloidal solution of silver is prepared by
    (a) colloidal milk
    (b) double decomposition method
    (c) Bredig's method (d) peptization

12. Alloy is an example of
    (a) gel (b) aero sol
    (c) solid sol (d) emulsion

13. Which of the following will have highest coagulating power for As_2S_3 colloid ?
    (b) Al^{3+} (b) PO_4^{3-}
    (c) Na^+ (d) SO_4^{2-}

14. Butter is a colloid formed when
    (a) fat is dispersed in casein
    (b) fat globules are dispersed in water
    (c) water is dispersed in fat
    (d) suspension of casein is in water

15. Gold number is the unit of
    (a) coagulating ability of ion
    (b) protective capacity of a hydrophilic sol
    (c) protective capacity of a hydrophobic sol
    (d) valency of a coagulating ion

16. Colloidal particles are visible through
    (a) compound microscope
    (b) naked eye
    (c) ordinary microscope
    (d) ultra microscope

17. One of the following is not a property typical of the lyophobic colloids
    (a) a sol that is not easily reversible
    (b) low concentration
    (c) low molecular weight
    (d) high viscosity

18. Tyndall effect is shown by
    (a) colloidal solution (b) solvent
    (c) precipitate (d) none of the above

19. An albumin sol containing sodium chloride as an impurity can best be freed of this impurity by
    (a) dialysis (b) electrophoresis
    (c) filtration (d) precipitation

20. A colloidal solution of egg albumin in water is an example of
    (a) association sol
    (b) macromolecular sol
    (c) micromolecular sol
    (d) multimolecular sol

21. Which of the following is a colloidal solution of a solid dispersed in air ?
    (a) Gems (b) Milk
    (c) Pumice stone (d) Smoke

22. Which one of the following is not a property of hydrophilic sols ?
    (a) High concentration of dispersed phase can be easily attained
    (b) Coagulation is reversible
    (c) Viscosity and surface tension are about the same as for water
    (d) The charge of the particle depends upon the pH values of the medium; it may be positive, negative or even zero

11

PHASE RULE

1. The mathematical statement of Gibb's phase rule is
   (a) $F = C - P + 2$ (b) $C = F - P + 2$
   (c) $C = F - P + 1$ (d) $P = C + F + 2$

2. The homogeneous physically distinct and mechanically seperable parts of the heterogeneous system in equilibrium

are called

(a) phases (b) components
(c) degrees of freedom (d) none of the above

3. What is the degree of freedom of a system consisting of a gaseous mixture of carbon dioxide and nitrogen ?
(a) 0 (b) 1
(c) 2 (d) 3

4. How many phases are present in the water system ?
(a) 0 (b) 1
(c) 2 (d) 3

5. How many phases will be there in the system made of water and methyl alcohol ?
(a) 3 (b) 2
(c) 1 (d) 0

6. How many components are necessary to define the following equilibrium ?

$$\underset{\text{solid}}{CaCO_3} \rightleftharpoons \underset{\text{solid}}{CaO} + \underset{\text{gas}}{CO_2}$$

(a) 0 (b) 1
(c) 2 (d) 3

7. The minimum number of phases existing in a system is
(a) 0 (b) 1
(c) 2 (d) 3

8. The incongruent melting point is also called
(a) peritectic temperature
(b) meritectic temperature
(c) transition temperature
(d) all of the above

PART II

Inorganic Chemistry

12

STRUCTURE OF ATOM

1. The mass on an electron is
   (a) 9.11×10^{-27}g (b) 9.11×10^{-38}g
   (c) 9.11×10^{-23}g (d) 9.11×10^{-28}g
2. The charge of proton is
   (a) 1.602×10^{-19}C (b) 1.502×10^{-19}C
   (c) 1.602×10^{-20}C (d) 1.502×10^{-23}C
3. Rutherford's experiment of α-particles showed for the first time that atom has
   (a) electrons (b) protons (c) neutrons (d) nucleus
4. Electromagnetic radiation is emitted
   (a) by all bodies
   (b) only by bodies at higher temperatures than their surroundings
   (c) only by the bodies at lower temperatures than their surroundings
   (d) only by radio and television antennas
5. There are no expected lines absent from the spectra of the
   (a) hydrogen (b) alkali metals
   (c) halogens (d) inert gases
6. The electron structures of atoms are not involved in the emission of
   (a) gamma rays (b) photoelectrons
   (c) spectral lines (d) X-rays
7. The electron in the Bohr model of the hydrogen atom is pictured as revolving around the nucleus in order for it to
   (a) emit protons
   (b) keep from being pulled into the nucleus
   (c) keep from being repelled by the nucleus
   (d) possess energy
8. Which of the following lies in the visible region ?
   (a) Balmer's series (b) Bracket's series
   (c) Paschen's series (d) Pfund's series

9. Which characteristic is different for the neutral atoms of the two isotopes of an element ?
   (a) Atomic number (b) Atomic weight
   (c) Number of electrons (d) Number of neutrons

10. The completed L-shell of an atom contains
    (a) 2 electrons (b) 6 electrons
    (c) 8 electrons (d) 10 electrons

11. A certain atom has 26 electrons and an atomic weight of 56. The number of neutrons in its nucleus is
    (a) 26 (b) 30 (c) 36 (d) 56

12. An element has atomic weight 39 and atomic number 19, the number of electrons, protons and neutrons in it will be respectively
    (a) 19, 19, 20 (b) 19, 20, 19
    (c) 20, 19, 19 (d) 39, 19, 39

13. Chlorine atom differs from chloride ion in the number of
    (a) electrons (b) protons
    (c) protons and electrons (d) neutrons

14. The maximun number of electrons which can occupy a dz^2 is
    (a) 1 (b) 2 (c) 3 (d) 4

15. The atomic number of Cr is 24, How many unpaired electrons would be present in its atom ?
    (a) 1 (b) 2 (c) 3 (d) 5

16. Electromagnetic waves transport
    (a) charge (b) energy
    (c) frequency (d) wave length

17. Which of the following is not electromagnetic in nature ?
    (a) Infrared rays (b) Radar waves
    (c) Ultravoilet rays (d) Sound waves

18. Which of the following statements is false of an orbital ?
    (a) It has always a negative value because it is occupied by a negatively charged particle
    (b) It has always a positive value because it is occupied by a negatively charged particle
    (c) It can go to zero only at infinity
    (d) All of the above

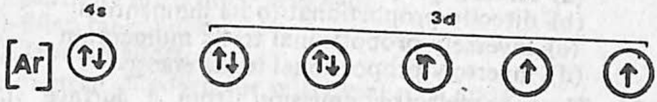
19. The statements
    "(i) In filling a group of orbitals of equal energy it is energetically preferable to assign electrons to empty orbitals rather than pair them into a particular orbital.

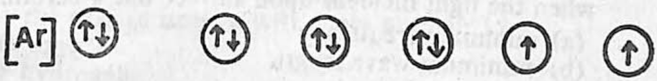
(ii) When two electrons are placed in two different orbitals energy is lower if the spins are parallel"

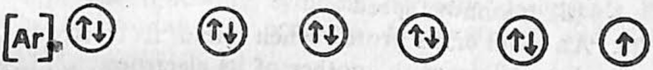
are valid for

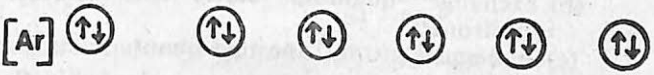
(a) Aufbau's principle (b) Hund's rule
(c) Pauli's exclusion principle
(d) Uncertainty principle

20. Which one of the following is *NOT* correct for electron distribution in the ground state ?

(a) Co


(b) Ni


(c) Cu


(d) Zn


21. Which one of the following is *NOT* the characteristic of Planck's quantum theory of radiations ?

(a) The energy is not absorbed or emitted in whole number multiples of quantum
(b) Radiation is associated with energy
(c) Radiation energy is not emitted or absorbed continuously but in the form of small packets called quanta
(d) The magnitude of energy associated with a quantum is proportional to the frequency

22. Heisenberg's uncertainty principle states that

(a) moving bodies exhibit both particle and wave properties
(b) moving charged particles resemble electromagnetic waves in their behaviour
(c) neither the position nor the momentum of a particle can ever be precisely determined
(d) the position and momentum of a particle cannot precisely be determined

23. The total energy of an atomic electron is

(a) less than zero
(b) zero

(c) more than zero
(d) sometimes more and sometimes less than zero.

24. The uncertainty principle can be applied to
(a) aeroplane (b) cricket ball
(c) electron (d) railway engine

25. de Broglie wave length associated with a material particle is
(a) directly proportional to its energy
(b) directly proportional to its momentum
(c) inversely proportional to its momentum
(d) inversely proportional to its energy

26. The photoelectric emission from a surface starts only when the light incident upon surface has a certain
(a) minimum frequency
(b) minimum wave length
(c) minimum intensity
(d) minimum speed

27. An atom emits proton when one of its electrons
(a) collides with another of its electrons
(b) exchange quantum states with another of its electrons
(c) undergoes a transition to a quantum state of lower energy
(d) undergoes a transition to a quantum state of higher energy

28. A p-orbital in the absence of the magnetic field is
(a) six-fold degenerate
(b) two-fold degenerate
(c) three-fold degenerate
(d) non-degenerate

29. Among the following orbitals which is spherically symmetrical ?
(a) 2p (b) 3d
(c) 4s (d) 4f

30. What is the de Broglie wave length of an electron when it is accelerated through a potential difference of 200V ?
(a) 6.92 pm (b) 23.6 pm
(c) 62.2 pm (d) 86.8 pm

31. For the hydrogen atom which of the following energy-level transitions will result in the emission of a proton with the greatest frequency ?
(a) From n = 3 to n = 1
(b) From n = 4 to n = 2

(c) From $n = 2$ to $n = 1$
(d) From $n = 1$ to $n = 4$

32. Which of the following transitions in a hydrogen atom emits the photons of highest frequency ?
(a) $n = 6$ to $n = 2$ (b) $n = 2$ to $n = 6$
(c) $n = 2$ to $n = 1$ (d) $n = 1$ to $n = 2$

33. Iron, cobalt and nickel owe their ferromagnetic properties to
(a) vacant inner sub shells
(b) partially filled inner subshells
(c) filled inner subshells
(d) Zeeman effect

34. The modern standard for relative atomic mass is
(a) naturally occurring carbon
(b) the carbon isotope with mass number 12
(d) oxygen
(d) hydrogen

35. Which of the following symbols correctly represents a species containing 11 protons, 12 neutrons and 10 electrons ?
(a) $^{23}Na^{+}$ (b) ^{22}Na
(c) ^{21}Ne (d) $^{20}Ne^{+}$

36. Nitrogen has three unpaired electrons because of
(a) Pauli's exclusion principle
(b) Aufbau principle
(c) uncertainty principle
(d) Hund's rule

37. Of the following elementary particles, the one that never decays in free space is the
(a) hyperon (b) neutron
(c) u-meson (d) proton

38. The modern atomic theory was first stated by
(a) Rutherford (b) Moseley
(c) Dalton (d) Bohr

39. The atoms of the different isotopes of a particular element differ from each other in the number of
(a) electrons in the outer shell only
(b) electrons in the inner shell only
(c) neutrons
(d) protons

40. A thin sheet of gold foil is bombarded with α-particles as in Geiger and Marsden's experiment. Which of the following descriptions most accurately represents the path of the α-particles ?

	Number of particles		
	undeflected	*deflected through a small angle*	*deflected through large angle*
(a)	all	none	none
(b)	most	a few	none
(c)	most	a few	a few
(d)	a few	most	a few

41. Which of the following ions would undergo the greatest deflection in a mass spectrometer ?
    (a) $^{1}H^{+}$ (b) $^{1}H^{-}$
    (c) $^{4}He^{+}$ (d) $^{4}He^{2+}$

42. The radio isotope sulphur-35 decays by β-emission. Which one of the following symbols correctly represents the isotope produced when an atom of ^{35}S emits a β—particle ?
    (a) ^{35}Cl (b) ^{31}P
    (c) ^{34}S (d) ^{31}Si

43. When a beam of white light is dispersed by a prism, the colour which is refracted most is
    (a) blue (b) green
    (c) violet (d) yellow

44. Of the following, the radiations, with the longest wavelengths are
    (a) infrared (b) green rays
    (c) ultraviolet (d) x-rays

45. For which of the following processes will energy be absorbed ?
    (a) Separating an electron from electron
    (b) Separating an electron from proton
    (c) Separating a proton from proton
    (d) Separating a neutron from neutron

46. With increasing quantum numbers, the energy difference between adjacent levels is
    [✓ (a) decreasing] (b) increasing
    (c) remaining same
    (d) sometimes increasing and sometimes decreasing

47. Elements upto atomic number 103 have been synthesized and studied till now. If an element with atomic number

106 were ever discovered, which of the following electronic configurations will it possess ?

(a) [Rn] $5f^{14}\ 6d^4\ 7s^2$
(b) [Rn] $5f^{14}\ 6d^1\ 7s^2\ 7p^3$
(c) [Rn] $5f^{14}\ 6d^6\ 7s^0$
(d) [Rn] $5f^{14}\ 6d^5\ 7s^1$

48. An element in which there are two incomplete shells is an atom of

(a) an inner transitional element
(b) a normal element
(c) a rare gas
(d) a transitional element

49. Which one of the following radio-isotopes is used in the determination of the age of archaeological samples ?

(a) Carbon-14 (b) Hydrogen-3
(c) Oxygen-18 (d) Phosphorus-32

50. Which one of the following processes can occur in the formation of an ion from an atom ?

(a) Gain of electrons (b) Gain of protons
(c) Loss of electrons (d) Loss of protons

13

PERIODIC CLASSIFICATION

1. In the periodic classification, the elements are arranged

(a) as covalent and electrovalent
(b) as metals and non-metals
(c) according to their atomic weights
(d) according to their atomic numbers

2. The properties of the elements are

(a) a periodic function of their atomic weights
(b) a periodic function of their atomic numbers
(c) determined by the number of neutrons and protons in the nuclei
(d) similar in the same horizontal period

3. The ionisation energy of nitrogen is more than oxygen because of
   (a) more attraction of electrons by the nucleus
   (b) more penetration effect
   (c) the extra stability of half filled p-orbitals
   (d) the size of nitrogen atom is smaller

4. Elements in the same family
   (a) have same atomic number
   (b) have the same molecular weight
   (c) have similar chemical properties
   (d) constitute a group of elements with the same electronic configuration.

5. Which of the following has highest first ionization energy?
   (a) Br (b) Cl
   (c) F (d) I

6. The atom which has two ionisation energies is
   (a) carbon (b) helium
   (c) hydrogen (d) oxygen

7. Which oxides are acidic, or more acidic than basic?
   (a) B_2O_3 (b) CO_2
   (c) Li_2O (d) CaO

8. A pair of elements in the same family in the periodic classification is
   (a) chlorine and carbon
   (b) calcium and aluminium
   (c) nitrogen and neon
   (d) sodium and potassium

9. Electronegative elements
   (a) are attracted to the cathode during electrolysis
   (b) are members of the same series in periodic classification
   (c) are usually metals
   (d) may gain electrons to give negatively charged ions

10. Which hydride has high melting point and is also good electrolyte when fused ?
   (a) NaH (b) SiH_4
   (c) HCl (d) H_2S

11. Which ion has the largest radius ?
   (a) Al^{+3} (b) Cl^-
   (c) F^- (d) O^{2-}

12. Which atom has the smallest size ?
   (a) C (b) F
   (c) Li (d) Rb

13. Which atom has the highest ionisation energy ?
    (a) Be (b) F
    (c) N (d) Ne

14. The most electronegative element is
    (a) fluorine (b) iodine
    (c) oxygen (d) sodium

15. The element with the highest first ionization potential is
    (a) boron (b) carbon
    (c) nitrogen (d) oxygen

16. In the 6th period of periodic table 14 elements are placed in the third group. They are known as
    (a) alkali metals (b) alkaline earth metals
    (c) rare gases (d) rare earths

17. Most of the known elements are
    (a) crystalloids (b) metals
    (c) metalloids (d) non-metals

18. Which of the following elements has the lowest first ionisation energy ?
    (a) Na (b) F
    (c) I (d) Cs

19. Which of the following ions forms a hydroxide highly soluble in water ?
    (a) K^+ (b) Ni^{+2}
    (c) Zn^{+2} (d) Al^{+3}

20. Which is the most basic of the following oxides ?
    (a) Na_2O (b) BaO
    (c) As_2O_3 (d) Al_2O_3

21. In the period, the elements are arranged in strict sequence in order of
    (a) increasing charges in the nucleus
    (b) increasing atomic weight
    (c) increasing number of electrons in valence shell.
    (d) increasing valency

22. Elements in IB group are called
    (a) coinage metals (b) alkali metals
    (c) alkaline earths (d) transitional metals

23. Most of the known elements are metals
    (a) of d-block of periodic table
    (b) of p-block of periodic table
    (c) of III-group of periodic table
    (d) of zero group of periodic table

24. Moseley's work led to the periodic law which states that
    - (a) the number of the electrons in the 1s energy level increases as the atomic number increases
    - (b) the properties of the elements are a periodic function of their atomic masses
    - (c) the X-ray spectra of the elements are more complex than the optical spectra
    - (d) the properties of elements are the periodic function of their atomic numbers.

25. Which of the following electronic configurations correspond to alkali metal ?

    (a) $1s^2\ 2s^1$ (b) $1s^2\ 2s^2\ 2p^6$
    (c) $1s^2\ 2s^2\ 2p^5$ (d) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$

26. Which one of the following is hydrolysed in water ?

    (a) SF_4 (b) CF_4
    (c) CO (d) $SiCl_4$

27. The elements of group IA and IIA are classed as
    - (a) s-block elements
    - (b) p-block elements
    - (c) typical elements
    - (d) bridge elements

28. The smallest ionic radius among the following is

    (a) K^+ (b) Ca^{2+}
    (c) Sc^{3+} (d) Ti^{+4}

29. As we move from left to right in second period of the periodic table, the gram atomic volume of the elements
    - (a) increases at a constant rate
    - (b) remains unchanged
    - (c) decreases
    - (d) will change indefinitely.

30. The most electropositive among the following elements is

    (a) Fe (b) Na
    (c) Cs (d) Pb

31. The correct order of second ionization potential of carbon, nitrogen, oxygen and fluorine is

    (a) $O>F>N>C$ (b) $O>N>F>C$
    (c) $C>N>O>F$ (d) $F>O>N>C$

32. Electron affinity depends to some extent upon the type of orbital that the added electron enters. It follows the order

    (a) $s<d<p<f$ (b) $s>d>p>f$
    (c) $s>p>d>f$ (d) $s<p<d<f$

33. Which of the following is a transition element ?

(a) Ni (b) Rb
(c) Al (d) As

34. Which is the most volatile compound ?

(a) HI (b) HCl
(c) HBr (d) HF

35. The lowest ionisation energies are found in the

(a) inert gases
(b) alkali metals
(c) transition elements
(d) halogens

36. The highest ionisation energies are found in the

(a) inert gases
(b) alkali metals
(c) transition elements
(d) halogens

37. Each vertical row of the periodic table includes elements with chemical characteristics that are in general

(a) identical
(b) similar
(c) different
(d) sometimes identical and sometimes different

14

CHEMICAL BONDS AND MOLECULES

1. What type of bond is obtained by the transfer of an electron from one atom to another ?

(a) Covalent bond (b) Coordinate bond
(c) Ionic bond (d) Hydrogen bond

2. Bond formed by sharing of electrons by two carbon atom is

(a) covalent bond (b) coordinate bond
(c) ionic bond (d) hydrogen bond

3. The bond between H and O in water is

(a) purely covalent

(b) purely ionic
(c) partly ionic and predominantly covalent
(d) partly covalent and predominantly ionic

4. Type of bond obtained in the molecule of KF is
(a) covalent bond (b) ionic bond
(c) hydrogen bond (d) peptide linkage.

5. The electronic arrangement of some element is as under $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$.
In reactions it is most likely to
(a) gain one electron
(b) gain or share 2 electrons
(c) lose or share 1 electron
(d) share 1 electron

6. Which of the following molecules has zero dipole moment ?
(a) HF (b) HCl
(c) CO_2 (d) H_2O

7. Choose the formula for calcium cyanamide
(a) $Ca(CN)_2$ (b) $CaCN_2$
(c) $CaCN_3$ (d) $CaCNH_3$

8. Choose correct formula for phosphoric acid
(a) HPO_3 (b) H_3PO_2
(c) H_3PO_3 (d) H_3PO_4

9. Hydrogen bonding is present in
(a) H_2 (b) paraffin
(c) ice (d) benzene

10. Which is not a linear molecule ?
(a) OF_2 (b) BeF_2
(c) CS_2 (d) CO_2

11. Who suggested that every element has a certain maximum covalency depending upon its atomic number ?
(a) Bohr (b) Pauling
(c) Sidgwick (d) Thomson

12. Maximum covalency of an element is limited to
(a) 6 (b) 7
(c) 8 (d) 9

13. The geometry of sp^3 hybrid orbitals is
(a) square planar (b) tetrahedral
(c) plane triangular (d) pyramidal

14. Which type of hybridization is found in ethane ?
(a) sp^3d (b) sp^3
(c) sp^2 (d) sp

15. Which of the following has a bond order of zero ?
    (a) F_2 (b) O_2
    (c) N_2 (d) Ne_2

16. Which of the following is not a type of a crystal ?
    (a) Triclinic (b) Rhombohedral
    (c) Hexagonal (d) Isomorphous

17. Variable valency is shown by
    (a) transition elements (b) normal elements
    (c) metallic elements (d) non-metallic elements

18. Tetrahedral nature of bonding in carbon atom was first shown by
    (a) Kekule (b) Lewis
    (c) Vant Hoff and Le Bel (d) Wohler

19. Which concept best explains the fact that *o*-nitrophenol is more volatile than *p*-nitrophenol ?
    (a) Hyperconjugation
    (b) Hydrogen bonding
    (c) Steric hindrance
    (d) Resonance

20. Which one of the following species has the highest bond order ?
    (a) O_2^+ (b) O_2
    (c) O_2^- (d) O_2^{-2}

21. Out of the following compounds indicate the one that possesses dipole moment
    (a) carbon-dioxide (b) benzene
    (c) methane (d) water

22. The geometric form of crystals is the result of orderly arrangement of
    (a) molecules only (b) ions only
    (c) atoms only
    (d) molecules, atoms or ions

23. In a covalent compound the lattice points are occupied by
    (a) atoms (b) ions
    (c) molecules (d) electrons

24. The elements cannot combine to give
    (a) a gas (b) a liquid
    (c) a compound (d) an element

25. What kind of symmetry is observed in a match box ?
    (a) Cubic (b) Monoclinic
    (c) Orthorhombic (d) Tetragonal

26. In a metallic solid the lattice points are occupied by
    (a) electrons (b) cations
    (c) anions (d) none of the above

27. Which of the following exhibits square planar structure ?
    (a) BF_4^- (b) CF_4
    (c) SeF_4 (d) XeF_4

28. The bond formed by maximum overlapping of s-s, p-s or p-p orbitals along the axes is
    (a) delta (b) ionic
    (c) pie (d) sigma

29. A crystal whose upper energy band is partially occupied by an electron is
    (a) conductor (b) insulator
    (c) n-type semi-conductor
    (d) p-type semi-conductor

30. current in n-type semiconductor is carried by
    (a) electrons (b) electrolytes
    (c) holes (d) positive ions

31. Hole in a p-type semiconductor is
    (a) a donor level
    (b) an excess electron
    (c) a missing atom
    (d) a missing electron

32. Which has a bond order of three ?
    (a) Cl_2 (b) H_2
    (c) N_2 (d) O_2

33. Which type of hybridization is formed in propane ?
    (a) sp (b) sp^2
    (c) sp^3 (d) dsp^2

34. Choose the correct statement
    (a) molecular fluorine is paramagnetic
    (b) molecular nitrogen is paramagnetic
    (c) molecular oxygen is paramagnetic
    (d) molecular oxygen is diamagnetic

35. The angle H-N·H in ammonia is
    (a) 120° (b) 109°28′
    (c) 106°45′ (d) 90°

36. The bond present in KH is
    (a) covalent (b) coordinate
    (c) hydrogen (d) ionic

37. The electrovalent bonding is not exhibited by
    (a) carbon dioxide (b) calcium chloride
    (c) potassium nitrate (d) sodium chloride

38. The number of chloride ions surrounding sodium ion in NaCl is
    (a) 2 (b) 4 (c) 6 (d) 8
39. In diamond, each carbon atom is covalently bonded to
    (a) 2 other carbon atoms
    (b) 4 other carbon atoms
    (c) 6 other carbon atoms
    (d) 8 other carbon atoms
40. Doping germanium with a little boron will produce
    (a) a n-type semiconductor
    (b) a p-type semiconductor
    (c) a n-p junction
    (d) an excess of electrons

15

NUCLEAR AND RADIOCHEMISTRY

1. When nitrogen nucleus containing six neutrons emits a positron, the product is
    (a) $^{13}_{7}N$ (b) $^{14}_{7}N$
    (c) $^{14}_{6}C$ (d) $^{13}_{6}C$
2. An alpha particle is essentially
    (a) an electron (b) a proton
    (c) a positron (d) a helium nucleus
3. Strong support for the liquid-drop model of the nucleus comes from
    (a) the existence of "magic number"
    (b) the approximate constancy of nuclear densities
    (c) the observed nuclear binding energies
    (d) nuclear fusion
4. Isotopes which are below the belt of stability are likely to be
    (a) positron emitters (b) electron emitters
    (c) α-emitters (d) stable
5. A very unstable isotope has a
    (a) very high kinetic energy

(b) very short-half life
(c) strong tendency to undergo fusion
(d) strong tendency to emit positron

6. Gamma rays are
(a) high energy electrons
(b) low energy electrons
(c) high energy electromagnetic waves
(d) high energy positrons

7. Which of the following is not radioactive ?
(a) $^{13}_{6}C$
(b) $^{13}_{7}N$
(c) $^{3}_{1}H$
(d) $^{5}_{2}He$

8. Natural radioactivity was discovered by
(a) Rutherford
(b) Henry Becquerel
(c) M. curie
(d) Schmidt

9. The first artificial transmutation of elements was carried out by
(a) M. curie
(b) I. curie
(c) Rutherford
(d) Soddy

10. The first nuclear reaction ever observed occurred when $^{14}_{7}N$ was bombarded with α-particles and protons were ejected. This reaction produces
(a) $^{17}_{7}N$
(b) $^{17}_{8}O$
(c) $^{17}_{9}F$
(d) $^{17}_{10}Ne$

11. Who was the first to produce artificial radioactivity ?
(a) Henry Becqueral
(b) I. Joliot curie and F. Joliot
(c) J.J. Thomson
(d) Pierre and Marie curie

12. Isotopes which undergo spontaneous fission are found
(a) above the belt of stability
(b) below the belt of stability
(c) beyond the belt of stability
(d) in the belt of stability

13. If there were no nuclear explosions, the ratio of $^{12}_{6}C$ to $^{14}_{6}C$ in the world would
(a) remain practically constant
(b) slowly decrease with time
(c) slowly increase with time
(d) rapidly increase with time

14. Support for the nuclear shell model of the nucleus is found in the existence of
(a) positrons
(b) beta-emitters
(c) liquid nuclei
(d) "magic numbers"

15. An isotope which has too high a neutron-proton ratio can gain stability by
    (a) β-emission (b) γ-emission
    (c) proton-emission (d) K-capture

16. If 1.0g of an isotope has a half life of 15 hr, the half life of 0.50g sample is
    (a) 15 hr (b) 30 hr (c) 7.5 hr (d) 60 hr

17. The β-decay of $^{24}_{11}Na$ produces an isotope of
    (a) Na (b) Ne (c) Mg (d) Al

Select the correct Answer in Questions 18-22.

18. In the decay of naturally radioactive isotope
    (a) the least penetrating of radiations is the β-rays
    (b) the daughter nuclei in α-decay have a mass number 2 less than the parent nuclei
    (c) The γ-rays are emitted when a daughter nucleus in the excited state changes into ground state
    (d) an increase in temperature increases the decay rate.

19. In the stability of the nucleus
    (a) when the number of protons and the number of neutrons are both even in number the isotope has the greatest chance of being stable
    (b) the neutron-proton ratio has the greatest stability for the nucleus when it has a value of 1.00
    (c) if the n/p ratio is too high the tendency is for α-decay to occur
    (d) unusual stability occurs if the total number of nucleons is 50

20. In nuclear fission and fusion
    (a) fission refers to the absorption of neutrons by the nucleus and the emission of α-particle
    (b) fusion reaction could be illustrated by the reaction

    $$^{1}_{1}H + ^{7}_{3}Li \rightarrow 2\ ^{4}_{2}He + \text{energy}$$

    (c) the critical mass for nuclear fission depends on the temperature and pressure of the system
    (d) fusion occurs at lower temperatures than fission

21. In induced radioactivity
    (a) the bombarding particles (protons, neutrons and deutrons) are accelerated to high velocities to overcome the repulsion of the nucleus and the bombarding particle
    (b) the conversion of one element into another is called disproportionation

(c) $^{14}_{7}N + ^{4}_{2}He \rightarrow ^{17}_{8}O + ^{1}_{1}H$ is a transmutation reaction
(d) very high energy neutrons are produced in the cyclotron

22. In radioactive decay
(a) the energies of the emitted particles are in the range of approximately 10^6eV
(b) a mass defect of 1 a. m. u. is equal to about 1KCal of energy
(c) the equation $N = N_0 e^{-\lambda t}$, has e = the electronic charge
(d) in separating the α, β and γ-radiations by an applied electrical or magnetic field the γ-rays being the highest are defected more than the other radiation

23. The radioactive disintegration of $^{238}_{92}U$ yields $^{234}_{90}Th$ and a/an
(a) electron (b) proton (c) neutron (d) α-particle

24. When bismuth target is irradiated with high energy helium ions, it produces
(a) platinum (b) astatine (c) americium (d) curium

25. The machine using magnetic mirrors is associated with
(a) optics (b) physical optics
(c) magnetism (d) fusion reactors

26. Which one of the following is considered to be an equivalent term to "mass defect" ?
(a) Atomic number
(b) Average atomic weight
(c) Binding energy
(d) Crystal dislocation

27. Complete the reaction
$^{226}_{88}Ra - ^{4}_{2}He \rightarrow$

(a) $^{222}_{88}Ra$ (b) $^{222}_{86}Rn$ (c) $^{223}_{87}Fr$ (d) $^{222}_{87}Fr$

28. In the nuclear reaction
$^{130}_{52}Te + ^{2}_{1}H \rightarrow ^{131}_{53}I + X$
predict what particle is X ?
(a) Deutron (b) Neutron
(c) Positron (d) Tritium

29. Which one of the following nuclear transformations is (n, p) type ?
(a) $^{7}_{3}Li + ^{1}_{1}H \rightarrow ^{7}_{4}Be + ^{1}_{0}n$

(b) ${}^{75}_{33}As + {}^{4}_{2}He \rightarrow {}^{78}_{35}Br + {}^{1}_{0}n$

(c) ${}^{209}_{83}Bi + {}^{2}_{1}H \rightarrow {}^{210}_{84}Po + {}^{1}_{0}n$

(d) ${}^{45}_{21}Sc + {}^{1}_{0}n \rightarrow {}^{45}_{20}Ca + {}^{1}_{1}H$

30. The amount of ${}^{128}_{53}I$ ($t_{\frac{1}{2}} = 25$min) left after 50 minutes will be
(a) $\frac{1}{4}$ (b) $\frac{1}{3}$ (c) $\frac{1}{2}$ (d) none

31. Of the following, the shortest life time is of
(a) neutrino (b) π^--meson
(c) π^+-meson (d) π°-meson

32. When two particles are very close together, the weakest interaction between them is
(a) strong (b) weak
(c) electromagnetic (d) gravitational

33. μ-Meson most closely resembles the
(a) π-meson (b) K-Meson
(c) electron (d) neutrino

34. The mass of neutrino is
(a) between that of electron and that of meson
(b) equal to that of electron
(c) greater than that of meson
(d) zero

35. Actinium series is also known as
(a) 4n series (b) (4n + 1) series
(c) (4n + 2) series (d) (4n + 3) series

36. Which of the following is its own antiparticle ?
(a) Neutrino (b) π°-Meson
(c) Neutron (d) Σ^+-hyperon

37. The heaviest class of elementary particles consists of
(a) baryons (b) leptons
(c) mesons (d) protons

16

OXIDATION AND REDUCTION

1. Which of the following is reduction ?
(a) $H_2S \rightarrow S$ (b) $Na^+ \rightarrow Na$
(c) $Fe^{+2} \rightarrow Fe^{+3}$ (d) $V_2O_5 \rightarrow NH_4VO_3$

2. Which of the following is oxidation ?
   (a) $MnO_2 \rightarrow Mn^{+2}$
   (b) $MnO_2 \rightarrow MnO_4^{-2}$
   (c) $MnO_2 \rightarrow MnO_4^-$
   (d) $MnO_4^- \rightarrow MnO_2$
3. The oxidation number of Ni in $K_4[Ni(CN)_4]$ is
   (a) 0 (b) −1 (c) +1 (d) −2
4. The combustion products of CS_2 would be
   (a) CO_2 and S
   (b) CO_2 and SO_2
   (c) CO_2 and H_2O_2
   (d) CO_2 and H_2SO_4
5. A solution of zinc chloride cannot be stored in a vessel made of
   (a) aluminium (b) lead
   (c) silver (d) gold
6. In which of the following compounds oxygen is in +2 state ?
   (a) Na_2O (b) OF_2 (c) SiO_2 (d) NO
7. The oxidation state of Mn in K_2MnO_4 is
   (a) +5 (b) +6 (c) +7 (d) +8
8. When zinc is added to copper sulphate solution,
   (a) zinc is reduced
   (b) zinc is oxidised
   (c) copper cation is oxidised
   (d) none of the above.
9. The oxidation number of S in SO_3^{-2} ion is
   (a) +2 (b) −2 (c) +4 (d) −4
10. The process of adding hydrogen to or removing oxygen from a substance is known as
    (a) oxidation
    (b) reduction
    (c) isomorphism
    (d) combustion
11. The oxidation number of an elementary substance is
    (a) 0 (b) 1 (c) 2 (d) 3
12. In compounds the oxidation number of fluorine is always
    (a) +1 (b) −1 (c) 0 (d) +2
13. Rusting of Iron is an example of
    (a) oxidation
    (b) reduction
    (c) absorption
    (d) adsorption

14. Compounds of manganese do not show paramagnetism when the oxidation state of manganese is
    (a) +4 (b) +6 (c) +5 (d) +7.

15. In $UO_2(NO_3)_2$ the oxidation number of uranium is
    (a) 0 (b) +2 (c) +4 (d) +6

16. Hg is transported in metal containers made of
    (a) Ag (b) Pb (c) Fe (d) Al

17. Hydrogen peroxide acts as
    (a) a reducing agent
    (b) an oxidising agent
    (c) a bleaching agent
    (d) all the above.

18. In the reaction $3Br_2 + 6CO_3^{-2} + 3H_2O \rightarrow 5Br^- + BrO_3^- + 6HCO_3^-$
    (a) bromine is oxidised and carbonate is reduced
    (b) bromine is reduced and water is oxidised
    (c) bromine is neither reduced nor oxidised
    (d) bromine is both reduced and oxidised

19. When K_2MnO_4 is converted to $KMnO_4$
    (a) K gets oxidised
    (b) oxygen loses an electron
    (c) manganate radical gets reduced
    (d) Mn loses one electron.

20. Which one of the following acids is least oxidising in nature ?
    (a) HOCl (b) $HClO_2$ (c) $HClO_3$ (d) $HClO_4$

21. Which one is a better oxidising agent ?
    (a) H_2 (b) Cl_2 (c) F_2 (d) N_2

22. Which statement is correct for $K_3\,Mo(CN)_8$?
    (a) Oxidation number of Mo is +3
    (b) Oxidation number of Mo is +5
    (c) Oxidation number of Mo is +8
    (d) Coordination number of Mo is 3

23. Which one is a redox reaction?
    (a) $AgNO_3$ solution is added to NaCl solution.
    (b) K_2CrO_4 solution is added to $Pb(NO_3)_2$ solution.
    (c) $K_2Cr_2O_7$ solution is added to NaOH solution.
    (d) Zinc is placed in $(CH_3COO)_2Pb$ solution.

24. Oxidation state of N in HN_3 is
    (a) $-\frac{1}{3}$ (b) 1 (c) $+\frac{1}{3}$ (d) +3

25, Fluorine is a powerful oxidising agent because of its
(a) low heat of association
(2) high heat of hydration
(c) both the above
(d) none of the above.

17

METALURGICAL OPERATIONS

1. In the Hall's process aluminium metal is obtained by
(a) electrolysis of aluminium salts in molten cryolite
(b) heating of aluminium salts in an atmosphere of CO_2
(c) heating of aluminium salts with carbon
(d) heating of aluminium salts in an atmosphere of nitrogen

2. In the metallurgy of iron, its ore, iron oxide, is reduced at a high temperature by
(a) carbon (b) silicon
(c) carbon monoxide (d) sulphur.

3. In the metallurgy of copper matte is considered to be a mixture of
(a) FeS and ZnS
(b) FeS and Cu_2S
(c) FeS and $CuCO_3$
(d) ZnS and Cu_2S.

4. Lead may be replaced from solutions of lead salts by
(a) copper (b) magnesium
(c) mercury (d) silver.

5. Taconite is an ore of
(a) copper (b) iron
(c) titanium (d) tungsten

6. Cinnabar is an ore of
(a) Hg (b) Pb
(c) Cu (d) Zn.

7. Bessemer converters are used to prepare
   (a) lead (b) steel
   (c) cobalt (d) wrought iron.
8. Which metal is extracted by electrolytic process?
   (a) Al (b) Mn
   (c) Ni (d) Zn.
9. Muffle furnace is used in metallurgy of
   (a) zinc (b) tin
   (c) lead (d) copper
10. Blast furnace is used in the metallurgy of
   (a) Cu (b) Fe
   (c) Pb (d) all the above
11. What type of refining methods is generally used in metallurgy?
   (a) Zone refining
   (b) Fire refining
   (c) Chemical refining
   (d) All the above
12. In addition to Cu, bronze contains
   (a) zinc (b) tin
   (c) zinc and tin (d) zinc and Lead
13. Galena is
   (a) ZnS (d) CuS
   (c) FeS (d) PbS
14. The process of stirring of molten metal with green wood poles is called
   (a) roasting (b) calcination
   (c) liquation (d) poling
15. German silver is an alloy of
   (a) Cu, Ni and Zn
   (b) Cu and Sn
   (c) Cu and Ag
   (d) Zn and Ag
16. Which is not the ore of copper ?
   (a) Cuprite (b) Malachite
   (b) Cinnabar (d) Copper pyrites.
17. The chief ore of aluminium is
   (a) Na_3AlF_6 (b) $Al_2O_3, 2H_2O$
   (c) Al_2O_3 (2) $Al_2O_3.H_2O$.
18. Name the Hardest metal
   (a) Silver (b) Gold
   (c) Platinum (c) Tungsten.

19. Aluminium is used in the thermit process because of its
    (a) resistance to corrosion
    (b) activity
    (c) lightness
    (d) silvery colour.

20. The froth flotation process is used in metallurgy to
    (a) concentrate the sulphide ore
    (b) oxidise sulphides
    (c) reduce oxides
    (d) decrease the density of electrolytes

21. What is Ferro-silicon?
    (a) It is an alloy of iron and silicon
    (b) It is an alloy of iron, silicon and tin
    (c) It is an alloy of iron, silicon and zinc
    (d) None of the above.

22. Lead is one of the components of
    (a) type metal (b) solder
    (c) both the above (c) none of the above

23. Which method of purification is represented by the equations ?

$$\underset{\text{(impure)}}{Ti+2I_2} \xrightarrow{500K} TiI_4 \xrightarrow{1675K} \underset{\text{(Pure)}}{Ti} + 2I_2$$

    (a) Cupellation
    (b) Poling
    (c) Van Arkel
    (d) Zone refining

24. From what mineral radium was obtained ?
    (a) Lime stone (b) Pitch blende
    (c) Rutile (d) Haematite

25. Which element is alloyed with copper to form bronze ?
    (a) Fe (b) Sn
    (c) Mn (d) Zn.

26. Which element forms brass when alloyed with copper ?
    (a) Pb (b) Zn
    (c) Bi (d) Sb

27. Which is the purest form of iron ?
    (a) Wrought Iron (d) Cast Iron
    (c) Pig iron (d) Steel

28. Carnallite is a mineral of
    (a) calcium (b) sodium
    (c) zinc (d) magnesium.

29. The cyanide process is used for obtaining

(a) Cr	(b) Cu
(c) Ag	(d) Zn

30. Blister copper is

(a) ore of copper
(b) alloy of copper
(c) pure copper
(d) copper containing 1% impurity.

31. Commercially important ore of lead is

(a) siderite	(b) galena
(c) sphalerite	(d) haematite

32. Essential constituent of an amalgam is

(a) Ag	(b) Hg
(c) Mg	(d) Fe

18

TRANSITION ELEMENTS

1. Manganese differs from most other transition elements because it reacts with

(a) oxygen	(b) water
(c) sulphur	(d) iodine

2. Which of the following elements can be included in the catagory of transition elements?

(a) Cu	(b) Al
(c) Ar	(d) At

3. Potassium ferrocyanide is a

(a) normal salt	(b) mixed salt
(c) double salt	(d) complex salt

4. Mn_3O_4 is

(a) an acidic oxide	(b) a basic oxide
(c) a neutral oxide	(d) an amphoteric oxide

5. Which set of elements is transitional in character?
(a) Fe, Co, Ni (b) **Ru, Rh, Pd**
(c) Os, Ir, Pt (d) All of the above

6. Elements Os, Ir, Pt belong to—group of the periodic table
(a) VIII (b) VII
(c) VI (d) V

7. Which of the following combinations is included in the Iron triad of elements?
(a) Pd and Pt (b) Mn and Hg
(c) Co and Ni (d) V and Ti

8. The highest common oxidation state of chromium is
(a) +4 (b) +5
(c) +6 (d) +7

9. A substance which is not paramagnetic is
(a) $Cr(ClO_4)_3$ (b) $KMnO_4$
(c) $TiCl_3$ (d) $VOBr_2$

10. Disproportionation is shown by
(a) $Cr(OH)_2$ (b) MnO_4^-
(c) $Cr(OH)_3$ (d) Mn^{+3}

11. A solution of $Cr(NO_3)_3$ slowly turns green when concentrated hydrochloric acid is added because of the formation of
(a) chloro complexes (b) $CrCl_3$
(c) Cr_2O_3 (d) CrO_2^-

12. Oxidation of Cr^{+3} in acid solution forms
(a) CrO_2^- (b) CrO_4^{-2}
(c) $Cr_2O_7^{-2}$ (d) Cr^{+2}

13. Reduction of MnO_4^- in strongly basic solution produces
(a) Mn^{2+} (b) MnO_4^{2-}
(c) MnO_2 (d) Mn_2O_7

14. A substance which is not amphoteric is
(a) V_2O_5 (b) $Cr(OH)_3$
(c) $Cr(OH)_2$ (d) Cr_2O_3

15. The ferricyanide ion is
(a) $Fe(CN)_4^{-6}$ (b) $Fe(CN)_6^{-4}$
(c) $Fe(CN)_3^{-6}$ (d) $Fe(CN)_6^{-3}$

16. The yellow colour of a solution prepared by adding 0.1 mole of $Fe(NO_3)_3$ to one litre of water is largely due to
(a) $FeCl^{+2}$ (b) $Fe(OH)^+$
(c) $Fe(OH)_4^-$ (d) $Fe(H_2O)_6^{+3}$

17. Iron may be rendered passive by treatment with a concentrated solution of
   (a) $H_2C_2O_4$ (b) HCl
   (c) HNO_3 (d) KSCN

18. In the Mond's process nickel is reacted with
   (a) HCN (b) HCl
   (c) NH_3 (d) CO

19. Oxdiation of Fe^{+2} in acid solution produces
   (a) $Fe(OH)_2$ (b) $Fe(OH)_3$
   (c) Fe^{+3} (d) $Fe(OH)^+$

20. Pig Iron usually contains about 4% of
   (a) Fe (b) C
   (c) S (d) Ca

21. Ferric oxide is:
   (a) a basic anhydride
   (b) an acid anhydride
   (c) an amphoteric anhydride
   (d) green

22. The most dense element is
   (a) Pb (b) Hg
   (c) Pt (d) Os

23. The most strongly ferromagnetic element is
   (a) Fe (b) Co
   (c) Ni (d) Os

24. Grey cast Iron contains
   (a) iron carbide (b) silicon dioxide
   (c) silicon carbide (d) graphite

25. The Edison storage cell is useful because
   (a) it supplies a constant voltage
   (b) it is inexpensive
   (c) it has no electrolyte
   (d) it never needs recharging.

26. The calcium in the lime-stone added to a blast furnace ends up in
   (a) slag (b) gangue
   (c) $CaCO_3$ (d) metallic calcium

27. The rusting of iron is catalyzed by:
   (a) Fe (b) O_2
   (c) Zn (d) H^+

28. Which one of the transition metal ions is coloured?
   (a) Cu^+ (b) Zn^{+2}
   (c) Sc^{+3} (d) V^{+4}

29. Which one is diamagnetic ?
(a) Co^{+2} (b) Ni^{+2}
(c) Cu^{+2} (d) Zn^{+2}

30. Which one has the lowest density ?
(a) Cu (b) Ni
(c) Sc (d) Zn

31. The purity of gold is measured in carats. The purest form is
(a) 24 carat (b) 23 carat
(c) 22 carat (d) 21 carat

32. Treatment of a solution containing $Ag(NH_3)_2^+$ with glucose yields
(a) Ag_2O (b) AgOH
(c) AgO (d) Ag

33. The black image on an exposed and developed photographic film is composed of
(a) Ag (b) Ag_2O
(c) AgBr (d) $[Ag(S_2O_3)_3]^{2-}$

34. Which one of the following metals exists in liquid form?
(a) Sc (b) Y
(c) La (d) Hg

35. The compound that gets oxidised even on exposure to air is
(a) $Co_2(SO_4)_3$ (b) $NiSO_4$
(c) $FeSO_4$ (d) $Ni(CO)_4$

36. Percentage of gold in 21.6 carat gold is
(a) 21.6% (b) 90%
(c) 10% (d) 70%

37. One of the constituents of german silver is
(a) Ag (b) Cu
(c) Mg (d) Al

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COORDINATION CHEMISTRY

1. The degree of hardness of water is measured by
   (a) EDTA method (b) distillation method
   (c) conductivity method (d) all of the above

2. Which reagent can be used to identify nickel ion ?
   (a) Resorcinol (b) Dimethylglyoxime
   (c) Diphenyl benzidine (d) Potassium Ferrocyanide

3. Potassium ferrocyanide is a
   (a) normal salt (b) mixed salt
   (c) double salt (d) complex salt.

4. Which of the following square planar complexes exhibits geometrical isomerism ?
   (a) MA_4 (b) MA_3
   (c) MA_2B_2 (d) MABCD

5. Which acts as a positive ligand in complexes ?
   (a) Amine (b) Aquo
   (c) Carbonyl (d) Nitrosonium.

6. Crystal field splitting is minimum in case of
   (a) $[Cr\ Cl_6]^{3-}$ (b) $[Cr\ (CN)_6]^{3-}$
   (c) $[Cr\ (NH_3)_6]^{3+}$ (d) $[Cr\ (H_2O)_6]^{3+}$

7. John-Teller distortion occurs in
   (a) d^3 (b) d^5
   (c) d^9 (d) d^{10}

8. Which would exhibit coordination isomerism ?
   (a) $[Cr\ (NH_3)_6]\ [Co\ (CN)_6]$
   (b) $[Co\ (en)_2\ Cl_2]^+$
   (c) $[Cr\ (NH_3)_6]\ Cl_3$
   (d) $[Cr\ (en)_2\ Cl_2]^+$

9. The correct name for $Cr(NH_3)_6Cl_3$ is
   (a) hexammine chromium (III) chloride
   (b) hexammine chromium (II) chloride
   (c) hexammine chromium (III) chloride
   (d) triammine chromium (III) chloride

10. A diamagnetic substance when placed in a magnetic field shows
    (a) decrease in weight
    (b) increase in weight
    (c) no change in weight
    (d) double of its weight
11. Which of the following is a high-spin d^6 complex ?
    (a) [Co $(NH_3)_4Cl_4]Cl_2$ (b) [Co $(NH_3)_3]Cl_3$
    (c) Trans [Co $(en)_2Cl_2]^-$ (d) cis [Co $(en)_2Cl_2)^+$

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ZERO GROUP

1. The electronic arrangement of an element is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
   What conclusion can be drawn from it ?
   (a) The atomic number of element is 18
   (b) The element is least reactive
   (c) The element belongs to zero group of the periodic table
   (d) All statements made above are correct
2. The electronegativity of zero group elements is
   (a) maximum (b) minimum
   (c) zero (d) not definite
3. All inert gases with the exception of—have an octet of electrons (s^2p^6) in their outermost shell
   (a) He (b) Ne
   (c) Ar (d) None of the above
4. The noble gases are
   (a) diatomic (b) monoatomic
   (c) triatomic (d) none of the above
5. Why is helium preferred to hydrogen for use in airships ?
   (a) Because helium has a lower density
   (b) Because helium is chemically less reactive
   (c) Because helium has a higher density
   (d) Because helium is chemically more reactive

6. The element radon is a member of
   (a) inert gas family
   (b) actinide series
   (c) alkali metals
   (d) lanthanide series
7. Helium was discovered by
   (a) Crookes
   (b) Frankland and Lokyer
   (c) Dorn
   (d) Rutherford
8. Radon is
   (a) drug (b) explosive
   (c) artificial fibre (d) noble gas
9. Which one of the following is least polarizable ?
   (a) He (b) Ne
   (b) Kr (d) Xe
10. The spectrum of He is similar to
   (a) H (b) Li^+
   (c) Na (d) He^+
11. The noble gas forming maximum number of compounds is
   (a) Ne (b) Xe
   (c) Kr (d) Rn
12. The age of a radioactive-rock can be found by
   (a) measuring the amount of helium emitted
   (b) determining its radioactivity
   (c) estimating rare earths and uranium
   (d) determining the total amount of noble gases produced
13. The ratio of $\frac{C_p}{C_v}$ or inert gas is
   (a) 1.66 (b) 1.33
   (c) 2.33 (d) 1.99

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HYDOGEN, WATER AND HYDROGEN PEROXIDE

1. An example of a covalent hydride is
   (a) NaH (b) CaH_2
   (c) SrH_2 (d) AsH_3
2. A substance exhibiting hydrogen bonding is
   (a) $CaH_2(s)$ (b) $NaH(s)$
   (c) $NH_3(l)$ (d) $H_2(g)$
3. Hydrogen may be readily prepared by the action of water on
   (a) iron (b) HCl
   (c) zinc (d) sodium
4. Ionic hydrides are usually
   (a) liquids at room temperature
   (b) good reducing agents
   (c) good electrical conductors when solid
   (d) easily reduced
5. The following two molecules have practically the same mass
   (a) H_2O and D_2O (b) H_2O and HOT
   (c) D_2O and HOT (d) DOT and HOD
6. Which one has the lowest boiling point ?
   (a) NH_3 (b) PH_3
   (c) AsH_3 (d) SbH_3
7. The proton is expected to have a very large
   (a) ionization potential (b) radius
   (c) charge (d) hydration energy
8. A tritium nucleus has
   (a) one proton and two electrons
   (b) one proton and two neutrons
   (c) one neutron and two protons
   (d) one proton and three neutrons
9. The following reaction is fast at room temperature
   (a) $2H_2(g)+O_{2(g)} \rightarrow 2H_2O(g)$
   (b) $H_2(g)+F_{2(g)} \rightarrow 2HF(g)$
   (c) $CO(g)+2H_{2(g)} \rightarrow CH_3OH(g)$
   (d) $3H_2(g)+N_{2(g)} \rightarrow 2NH_3(g)$

10. The hydronium ion is a/an
    (a) ion with the formula H_2O^+
    (b) ion with the formula H_3O^+
    (c) free radical rather than an ion
    (d) ion formed by removal of H^- from a water molecule.

11. H_2O is
    (a) more polar than H_2S
    (b) less polar than H_2S
    (c) more or less identical in polarity with H_2S
    (d) none of the above

12. Which of the following is the strongest base ?
    (a) NH_3
    (b) PH_3
    (c) AsH_3
    (d) SbH_3

13. Which is the purest form of water ?
    (a) Surface water
    (b) Rain water
    (c) Well water
    (d) Mineral water

14. Hydrogen is an important constituent of
    (a) water
    (b) petroleum
    (b) natural gas
    (d) all the above

15. When liquid air is fractionally distilled the following will be obtained as last fraction ?
    (a) Hydrogen
    (a) Helium
    (c) Nitrogen
    (d) Oxygen

16. The symbol of hydride ion is
    (a) H
    (b) H_2
    (c) H
    (d) H^-

17. The boiling point of water is
    (a) 100°C
    (b) 212°F
    (c) 80°R
    (d) All the above are correct

18. The high boiling point of water is due to
    (a) its high specific heat
    (b) its dielectric constant
    (c) weak dissociation of water molecules
    (d) hydrogen bonding among water molecules.

19. Heavy water is qualified as heavy because it
    (a) is an oxide of deuterium
    (b) has a heavy or bad taste
    (c) is denser than common water
    (d) has a heavier isotope of oxygen

20. What is the commonest gas in the atmosphere ?
(a) He (b) N_2
(c) NH_3 (d) H_2

21. D_2O will have maximum density at
(a) 9°C (b) 11.5°C
(c) 15.9°C (d) 20°C

22. Decomposition of H_2O_2 can be retarded by addition of a small amount of acetamide. It acts as a
(a) retarder (b) stopper
(c) stabilizer (d) oxidizer

23. The element which does not form salt-like hydride is
(a) sodium (b) calcium
(c) zinc (d) silicon.

24. Which substance is not used to soften hard water ?
(a) Calcium hydroxide (b) Sodium carbonate
(c) Calcium sulphate (d) Permutit.

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GROUP IA—ALKALI METALS

1. When NaCl is dissolved in water, the sodium ions become
(a) oxidized (b) reduced
(c) hydrolyzed (d) hydrated.

2. Sodium is not observed in + 2 oxidation state because of its
(a) high first ionization potential
(b) high second oxidation potential
(c) high ionic radius
(d) high electronegativity.

3. The colour of the flame of potassium is
(a) red (b) yellow
(c) green (d) violet

4. Rubidium reacts with oxygen to form
(a) RbO (b) Rb_2O
(c) Rb_2O_2 (d) RbO_2

5. The metallic lustre of sodium is explained by the presence of
   (a) Na^+ ions
   (b) conduction electrons
   (c) free protons
   (d) a body centred cubic lattice

6. The OH^- concentration of a solution prepared by adding one mole of Na_2O to enough water to prepare one litre solution is
   (a) 0.5 M (b) 0.2 M
   (c) 1.0 M (d) 2.0 M

7. The strongest reducing agent of the alkali metals is
   (a) Li (b) Na
   (c) K (d) Cs

8. If one gram-atom of cesium is added to enough water to make one litre of solution, the resulting OH^- concentration will be
   (a) 0.2 M (b) 0.5 M
   (c) 1 M (d) 2 M

9. On fusion with Na_2CO_3, AgCl gives
   (a) silver (b) silver oxide
   (c) sodium sulphide (d) silver carbide

10. Which of the following substances is manufactured by electrolysis of NaCl solution ?
    (a) NaOH (b) NaClO
    (c) $NaClO_3$ (d) Na

11. The formula of washing soda is
    (a) $Na_2CO_3.7H_2O$ (b) $Na_2CO_3.H_2O$
    (c) $Na_2CO_3.10H_2O$ (d) Na_2CO_3

12. NaCl imparts a golden yellow colour to the Bunsen flame. This can be interpreted due to
    (a) low ionization potential of sodium
    (b) photosensitivity of sodium
    (c) sublimation of metallic sodium to give yellow vapour
    (d) emission of excess energy absorbed as a radiation in the visible region

13. Which compound would be most apt to be easily purified by crystalization from water ?
    (a) NaCl (b) KCl
    (c) KBr (d) KNO_3

14. In the alkali metal series which of the following is most reactive ?
    (a) Li (b) Na
    (c) K (d) Rb

15. Give the formula of sodium bismuthate

(a) $Na_2 Bi_4O_7$ (b) Na BiO
(c) Na BiO_3 (d) $Na_2 BiO_3$

16. In the alkali metal series, caesium is the most reactive metal because

(a) its incomplete shell is nearest to the nucleus
(b) the valence electron has a larger orbit than the orbit of the valence electron of any of the others
(c) it exerts considerable attractive force on the valence electrons
(d) it is a heavier metal

17. 50 ml of a lithium hydroxide solution can completely neutralize 25 ml of 2 M phosphoporic acid. The molarity of lithium hydroxide is

(a) 2 (b) 3
(c) 4 (d) 5

18. Potassium hydride contains

(a) covalent bond (b) metallic bond
(c) ionic bond (d) coordinate bond

19. An apparatus used for commercial preparation of sodium is named after

(a) Carius (b) Down
(c) Schmidt (d) Haber

20. Of the following compounds which is most stable ?

(a) LiF (b) LiCl
(c) LiBr (d) LiI

21. Baking soda is also called

(a) caustic soda (b) soda ash
(c) washing soda (d) bicarbonate of soda

22. Which does not belong to alkali metals ?

(a) Li (b) Na
(c) K (d) Ra

23. Which is most commonly used to dry organic liquids ?

(a) Li (b) Na
(c) K (d) Rb

24. A graphite anode is used in Down's cell for the production of sodium because

(a) it does not react with sodium
(b) it does not react with chlorine
(c) it is easy to fashion in circular form
(d) it floats on the fused sodium chloride

25. Which one is a reducing agent and a constituent of gun powder ?
(a) KNO_3 (b) C
(c) $CaCO_3$ (d) Na

26. Atoms of alkali metals are attached by
(a) covalent bonds (b) ionic bonds
(c) metallic bonds (d) electrons

27. The radius of K-atom is 2.31 A. The radius of K^+ will be
(a) 0.13 A (b) 1.33 A
(c) 2.31 A (d) 2.30 A

28. LiCl is soluble in organic solvents while NaCl is not. This is because
(a) lattice energy of NaCl is less than that of LiCl
(b) Li^+ has higher value of hydration energy than that of Na^+
(c) LiCl is more covalent in nature than NaCl
(d) Li^+ has lower value of hydration energy than Na^+

29. Which of the following is a strongest base ?
(a) Li (OH) (b) NaOH
(c) KOH (d) RbOH

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GROUP IIA–ALKALINE EARTHS

1. Of all the group II elements, the highest oxidation potential is for
(a) Li (b) Be
(c) Ba (d) Ra

2. "Soap Scum" is often composed of
(a) sodium carbonate
(b) calcium carbonate
(c) sodium stearate
(d) calcium stearate.

3. Which of the following undergoes disproportionation?
(a) Ba^{+2} (b) Ba^+
(c) $BaCl_2$ (d) BaH_2

4. The hydration energy of Mg^{+2} is larger than that of
   (a) Al^{+3} (b) Be^{+2}
   (c) Mg^{+3} (d) Na^{+}
5. Which one has the lowest pH?
   (a) 0.1M $BaCl_2$ (b) 0.1M $Ba(NO_3)_2$
   (c) 0.1M $BaCl_2$ (d) 0.1M $Ba(OH)_2$
6. Temporary hardness of water can be removed by the addition of
   (a) $CaCO_3$ (b) $Ca(OH)_2$
   (c) $CaCl_2$ (d) HCl
7. Water which has been passed successively through a cation and an anion exchanger may still be impure because of the presence of
   (a) H^{+} (b) OH^{-}
   (c) molecular impurities
   (d) Zeolite molecules
8. Which one has the highest lattice energy?
   (a) $Be(OH)_2$ (b) $Mg(OH)_2$
   (c) $Ca(OH)_2$ (d) $Ba(OH)_2$
9. When CO_2 is bubbled into an aqueous solution of Na_2CO_3, the following is formed
   (a) NaOH (b) HCO_3^{-}
   (c) H_2O (d) OH^{-}
10. A dehydrating agent commonly used in the laboratory is
    (a) $MgCO_3$ (b) CaF_2
    (c) $CaCl_2$ (d) MgF_2
11. The flame test colour of strontium is
    (a) yellow (b) green
    (c) yellow-green (d) red
12. Hard water is
    (a) water containing Ca^{+2}, Mg^{+2} or Fe^{+2}
    (b) water containing HCO_3^{-}
    (c) water containing Na^{+}
    (d) ice
13. Which of the following is not produced during Solvay process?
    (a) CO_2 (b) CaO
    (c) $CaCl_2$ (d) All are produced
14. If one gram atom of Ba is added to enough water to make 10 litres of solution, the pH of the resulting solution is
    (a) 13.3 (b) 13.0
    (c) 0.7 (d) 1.0

15. Barium forms barium chloride by
    (a) the transfer of one electron from barium to chlorine
    (b) the transfer of two electrons from barium to chlorine
    (c) the transfer of one electron from chlorine to barium
    (d) the transfer of two electrons from chlorine to barium
16. Who discovered radium?
    (a) Kloprath (b) Fermi
    (c) Curies (d) Rutherford
17. Which of the following is not soluble in water ?
    (a) Na_2SO_4 (d) $BaSO_4$
    (c) $ZnSO_4$ (d) $CaSO_4$
18. Temporary hardness of water is caused by the presence of
    (a) magnesium carbonate
    (b) calcium sulphate
    (c) calcium carbonate
    (d) magnesium hydrogen carbonate
19. The most abundant source of $CaCO_3$ is
    (a) calcite (b) argentite
    (c) lime stone (d) apatite
20. Sedementary rocks laid down under water mainly consist of calcium
    (a) oxide (b) hydroxide
    (c) carbonate (d) sulphate
21. Bleaching powder is obtained by passing chlorine over
    (a) $CaCO_3$ (b) $Ca(OH)_2$
    (c) $Ca(HCO_3)_2$ (d) $CaSO_4$
22. Which of the following substances can produce permanent hardness in water?
    (a) Na_2SO_4 (b) $MgSO_4$
    (c) Na_2CO_3 (d) $Ca(HCO_3)_2$
23. Which of the following elements cannot be extracted commercially from sea water or marine plants?
    (a) Ca (b) Mg
    (c) Br_2 (d) I_2
24. Indicate a compound which on boiling an aqueous solution to dryness, will leave the anhydrous chloride ?
    (a) CsCl (b) $BeCl_2$
    (c) $MgCl_2$ (d) $AlCl_3$
25. In which of the oxides, magnesium will not burn ?
    (a) H_2O (b) CO_2
    (c) SO_2
    (d) will burn in all of them

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GROUP IIIA ELEMENTS

1. Which has highest first ionisation energy?
   (a) B (b) Al
   (c) Ga (d) In
2. Which has lowest oxidation potential ?
   (a) B (b) Al
   (c) Ga (d) In
3. Which forms the most acidic oxide ?
   (a) B (b) Al
   (c) Ga (d) In
4. Choose the ion which tends to hydrolyze the most
   (a) Al^{+3} (b) Ga^{+3}
   (c) Tl^{+} (d) Tl^{+3}
5. Choose the species which shows the largest tendency to form complexes with Al^{+3}
   (a) H_2O (b) F^-
   (c) Cl^- (d) SO_4^{-2}
6. Choose the substances used to produce red colouration in synthetic rubies
   (a) B_2O_3 (b) Al_2O_3
   (c) Na_3AlF_6 (d) Cr_2O_3
7. The octet rule is not obeyed in
   (a) NH_3 (b) $Al(OH)_4^-$
   (c) $BF_3.NH_3$ (d) BCl_3
8. Reaction of Mg_3B_2 with acid produces
   (a) B_2O_3 (b) MgB_2O_4
   (c) B_4H_{10} (d) MgB_4O_7
9. B^{+3} cannot exist in aqueous solution because of its
   (a) strong reducing ability
   (b) large size and small charge
   (c) small size and large charge
   (d) strong oxidizing ability.
10. When $Al(OH)_3$ is dissolved in NaOH solution, it results in the formation of
   (a) $Al(H_2O)_4(OH)_2^+$
   (b) $Al(H_2O)_3(OH)_3$
   (c) $Al(H_2O)_2(OH)_4^-$
   (d) AlO_2^+

11. One of the products of thermite reaction is
    (a) Fe_2O_3 (b) Al
    (c) Fe (d) CO_2

12. In the Hall-Heroult process for producing aluminium the substance produced at the cathode is
    (a) Al (b) Al_2O_3
    (c) F_2 (d) C

13. The following solid consist of ions of
    (a) CaB_2O_4 (b) BI_3
    (c) B_2H_6 (d) BF_3

14. The orthoborate ion is
    (a) tetrahedral
    (b) octabedral
    (c) square planar
    (d) triangular planar

15. Hydrogen gas may be produced by the reaction of aluminium with a concentrated solution of
    (a) Fe_2O_3 (b) NaOH
    (c) HNO_3 (d) NaF

16. The reduction of metal oxides is sometimes accomplished by using aluminium in the
    (a) Goldschmidt reaction
    (b) Silberschmidt reaction
    (c) Baeyer reaction
    (d) Zilch reaction

17. Aluminium resists corrossion due to the formation of a coat of
    (a) AlN (d) $Al(NO_3)_3$
    (c) Al_2O_3 (d) $Al_2(CO_3)_3$

18. The following is not an alum
    (a) $KAl(SO_4) .12H_2O$
    (b) $NH_4Al(SO_4)_2.12H_2O$
    (c) $NH_4Cr(SO_4)_2.12H_2O$
    (d) $Al_2(SO_4)_3.18H_2O$

19. Which is most acidic ?
    (a) Na_2O (b) MgO
    (c) Al_2O_3 (d) CaO

20. Al_2O_3 formation involves evolution of a large quantity of heat, which makes its use in
    (a) deoxidiser (b) confectionery
    (c) indoor photography (d) thermit welding

21. Duralum is an alloy which contains
    (a) Mg+Al (b) Mg+Cu+Al+Mn
    (c) Mg+Cu (d) Cu+Al
22. What is carborundum?
    (a) Al_2O_3 (b) SiC
    (c) $ZnSO_4$ (d) H_2PtCl_6
23. The solvent used in the extraction of aluminium from its ore is
    (a) cryolite (b) bauxite
    (c) molten sodium chloride (d) water
24. Which does not contain aluminium?
    (a) Felspar (b) Cryolite
    (c) Kaoline (d) Anhydrite
25. A mixture of $Al(OH)_3$ and $Fe(OH)_3$ can be separated easily on treatment with
    (a) NaOH solution (b) NH_4OH solution
    (c) HCl solution (d) HNO_3 solution
26. What is Corundum?
    (a) Al_2O_3 (b) SiC
    (c) $ZnSO_4$ (d) H_2PtCl_6
27. Which one of the following elements bears resemblance with gallium?
    (a) Si (b) Al
    (c) Ni (d) As

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GROUP IVA ELEMENTS

1. A product of thermal decomposition of sodium bicarbonate is
   (a) NaH (b) CO_2
   (c) $NaHCO_3$ (d) C_2H_2

2. Moderate electrical conductivity is exhibited by
(a) SiO_2 (b) graphite
(c) diamond (d) CO_2

3 An aqueous solution of following substance is basic
(a) $SnCl_2$ (b) $PbCl_2$
(c) CO_2 (d) Na_2CO_3

4. Iron may be rendered passive by the application of
(a) PbO (b) $Pb(OH)_2$
(c) $PbCO_3$ (d) Pb_3O_4

5. The oxidation state of carbon in sodium stearate, $NaOOCC_{17}H_{35}$ is
(a) -1.778 (b) $+4$
(c) -2 (d) 0

6. Glass is soluble in solution of
(a) HNO_3 (b) HCl
(c) HF (d) H_2CO_3

7. When stannous hydroxide is dissolved in excess base, we get
(a) $Sn(OH)_4$ (b) $Sn(OH)_6^{-2}$
(c) SnO_3^{-2} (d) $Sn(OH)_3^-$

8. The addition of the H^+ to a solution containing SnS_3^{-2} produces
(a) SnS (b) SnS_2
(c) SnO_3^{-2} (d) S_2^{-2}

9. Which of the following compounds is used as a refrigerant ?
(a) Acetone (b) CCl_4
(c) CF_4 (d) CF_2Cl_2

10. Poisonous gas present in the exhaust fumes of car is
(a) CH_4 (b) C_2H_2
(c) CO (d) CO_2

11. Producer gas is a mixture of
(a) nitrogen and methane
(b) CO and H_2O
(c) CO and nitrogen
(d) CO and hydrogen

12. The compound which contains both ionic and covalent bonds is
(a) CH_4 (d) H_2
(c) KCN (d) K

13. On heating with conc H_2SO_4 sucrose gives
(a) CO and CO_2 (b) CO and SO_2
(c) CO, CO_2 and SO_2 (d) none of the above

14. Lead tetraethyl is used as
(a) fire extinguisher (b) Pain killer
(c) petroleum additive (d) mosquito repellent

15. Litharge is chemically
(a) PbO (b) PbO_2
(c) Pb_3O_4 (d) $Pb(CH_3COO)_2$

16. Out of the following the hardest is
(a) peat (b) lignite
(c) anthracite (d) graphite

17. Which is the most abundant element in earth's crust ?
(a) Ca (b) Si
(c) C (d) O

18 Graphite is used in nuclear reactors
(a) as a lubricant
(b) as a fuel
(c) for lining the inside of reactor as an insultor
(d) for reducing the velocity of neutrons

19. Semi-water gas is a mixture of
(a) water gas and producer gas
(b) water gas and CO_2
(c) producer gas and CO_2
(d) producer gas and oil gas

20. The gas responsible for rising of bread is
(a) CO (b) CO_2
(c) NH_3 (d) O_2

21. Coal gas contains
(a) H_2, N_2, C_2H_4 (b) C_2H_4, CO, CH_4
(c) H_2, N_2, CO, CH_4 (d) H_2, N_2, C_2H_4, CH_4, CO

22. The chief impurity present in producer gas is
(a) H_2 (b) N_2
(c) CO (d) CH_4

23. The combustion products of CS_2 would be
    (a) CO_2 and S (b) CO_2 and SO_2
    (c) CO_2 and H_2O_2 (d) CO_2 and H_2SO_4

24. The charcoal used to decolourise brown sugar solution is
    (a) wood charcoal (b) coconut charcoal
    (c) animal charcoal (d) sugar charcoal

25. In the sale of diamonds the unit of weight is carat. One carat is equal to
    (a) 100 mg (b) 200 mg
    (c) 300 mg (d) 400 mg

26. Name two elements that find wide application in transistor industry
    (a) Silicon and germinium
    (b) Carbon and platinum
    (c) Iridium and germanium
    (d) Tungsten and platinum

27. What is the extent of carbon present in cast iron ?
    (a) 1−2% (b) 2.5−4.5%
    (c) 3−5% (d) 1−5%

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GROUP VA—ELEMENTS

1. Phosphine may be produced by the action of water on
   (a) Ca_3P_2 (b) P_4O_6
   (c) P_4O_{10} (d) HPO_3

2. Which of the following dissolves in water to give a basic solution?
   (a) H_3PO_3 (b) NaH_2PO_4
   (c) Na_2HPO_4 (d) $NaNO_3$

3. Which of the following is paramagnetic?
(a) NH_2OH (b) $N_2H_6Cl_2$
(c) N_2O_3 (d) NO_2

4. Oxidation of NO in air produces
(a) N_2O (b) N_2O_3
(c) N_2O_4 (d) N_2O_5

5. The dimerization of NO_2 as the temperature is lowered is accompanied by
(a) a decrease in paramagnetism
(b) an increase in pressure
(c) a darkening in colour
(d) the formation of a colloid

6. In the Ostwald's process, the substance which is used to oxidise NH_3 is
(a) NO_2 (b) Pt
(c) H_2O (d) O_2

7. The brown gas formed when metals reduce HNO_3 is
(a) N_2O_5 (b) N_2O_3
(c) NO_2 (d) NO

8. Lightning bolts in the atmosphere cause the formation of
(a) NO (b) NH_3
(c) NH_4OH (d) NH_2OH

9. In phosphorus oxide the number of oxygen atoms bonded to each phosphorus atom is
(a) 1 (d) 2
(c) 3 (b) 4

10. Of the following elements the only one which does not exhibit allotropy is
(a) P (b) As
(c) Sb (d) Bi

11. The molecular formula of phosphorus is
(a) P (b) P_2
(c) P_4 (d) P_5

12. The acidic hydride of nitrogen is
(a) N_2H_2 (b) N_2H_4
(c) NH_3 (d) N_3H

13. Laughing gas is chemically
(a) NO (b) N_2O
(c) N_2O_3 (d) N_2O_5

14. Which one of the following pentafluorides cannot be formed ?
(a) PF_5 (b) AsF_5
(c) SbF_5 (d) BiF_5

15. Which one of the following substances will be most useful to remove nitrogen from air ?
    (a) P (b) lime water
    (c) $CaCl_2$ (d) Mg.
16. Which of the following substances liberates hydrogen by its reaction with HCl ?
    (a) Copper (b) Mercury
    (c) Phosphorus (d) Magnesium
17. Phosgene is the common name for
    (a) carbon dioxide and phosphine
    (b) phosphoryl chloride
    (c) carbonyl chloride
    (d) carbon tetrachloride
18. The white deposit on laboratory glass panes is
    (a) $AgNH_2Cl$ (b) $CaCN_2$
    (c) NH_4Cl (d) KNO_3
19. The reaction of P with NaOH to produce PH_3 and NaH_2PO_2 is an example of
    (a) oxidation
    (b) reduction
    (c) oxidation and Reduction
    (d) neutralisation
20. The basicity of phosphoric acid is
    (a) 2 (b) 3
    (c) 4 (d) 6

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GROUP VIA—ELEMENTS

1. Large deposits of sulphur in nature are found as
   (a) sulphuric acid (b) sulphurous acid
   (c) hydrosulphuric acid (d) free sulphur
2. On the basis of available data of the structure of monoclinic sulphur, it probably consists of
   (a) S_8 chains (b) S_2 molecules
   (c) S_4 rings (d) S_8 rings

3. Rhombic sulphur consists of
   (a) S_8 chains (b) S_2 molecules
   (c) S_4 rings (d) S_8 rings

4. A 0.1 M $NaHSO_4$ solution is
   (a) acidic (b) basic
   (c) neutral (d) purple

5. $H_2S_2O_8$ is
   (a) a detergent
   (b) an intermediate obtained in the manufacture of H_2SO_4
   (c) thiosulphuric acid
   (d) a peroxy compound

6. Pure H_2SO_4 is a compound which
   (a) is always colloidal
   (b) slowly decomposes to form SO_2
   (c) serves as a useful source for H_2S
   (d) has never been observed

7. Sulphur burns in air to produce
   (a) SO_2 (b) SO_3
   (d) H_2SO_3 (d) S_2O_3

8. The form of sulphur which is stable at room temperature and normal atmospheric pressure is
   (a) orthorhombic (b) hexagonal
   (c) monoclinic (d) amorphous

9. When pure H_2SO_4 is electrolysed, the product at the anode is
   (a) $H_2S_2O_7$ (b) $H_2S_2O_8$
   (c) $H_2S_2O_3$ (d) $H_2S_4O_6$

10, Oxidation of $S_2O_3^{-2}$ by I_2 yields
   (a) SO_3^{-2} (b) SO_4^{-2}
   (c) $S_2O_7^{-2}$ (d) $S_4O_6^{-2}$

11. Colloidal sulphur may be produced by reaction between solutions of
   (a) $H_2S_2O_7$ and H_2SO_4
   (b) $Na_2S_2O_3$ and I_2
   (c) Na_2S and $FeCl_2$
   (d) $FeCl_3$ and H_2S

12. When HgS is dissolved in aqua regia, the function of HCl in the mixture is to
   (a) oxidize the sulphur (b) oxidize the mercury
   (c) complex the sulphur (d) complex the mercury

13. In Contact process of manufacture of H_2SO_4,SO_3 is not added to water directly to form H_2SO_4 because
    (a) the reaction does not go to completion
    (b) the reaction is exothermic
    (c) the reaction is quite slow
    (d) SO_3 is insoluble in H_2O

14. When liquid sulphur at one atmosphere pressure is very slowly cooled, unless super cooling occurs, the first solid to appear is
    (a) monoclinic sulphur (b) rhombic sulphur
    (c) hexagonal sulphur (d) metallic sulphur

15. The synthesis of ethers from alcohol depends on the fact that H_2SO_4 is a good
    (a) oxidizing agent (b) reducing agent
    (c) complexing agent (d) dehydrating agent

16. Pyrosulphuric acid may be synthesised by dissolving SO_3 in
    (a) H_2O (b) H_2SO_3
    (c) $H_2S_2O_4$ (d) $H_2S_2O_8$

17. Which one is not an acid anhydride ?
    (a) H_2S (b) SO_2
    (c) SeO_2 (d) TeO_2

18. Choose the substance used as a catalyst in the Contact process
    (a) Fe_2O_3 (b) V_2O_5
    (c) SO_3 (d) Ag_2O

19. Which of the following compounds is most soluble in water ?
    (a) HgS (b) K_2S
    (c) ZnS (d) SnS

20. Choose the strongest acid
    (a) H_2S (b) H_2Se
    (c) H_2Te (d) H_2O

21. A compound in which oxygen has a positive oxidation state is
    (a) H_2O_2 (b) $Na_2S_2O_3$
    (c) ClO_2 (d) OF_2

22. $BaSO_3$ is soluble in a dilute solution of
    (a) NaOH (b) NH_3
    (c) $BaCl_2$ (d) HNO_3

23. Which of the following has the highest catenation capability ?
    (a) oxygen (b) sulphur
    (c) selenium (d) tellurium
24. Which one of the following species has the maximum number of unpaired electrons ?
    (a) O_2 (b) O_2^+
    (c) O_2^- (d) O_2^{2-}
25. A black sulphide is formed by the action of H_2S on
    (a) NaCl (b) $CdCl_2$
    (c) $ZnCl_2$ (d) $CuCl_2$

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GROUP VIIA ELEMENTS

1. The halogen with the highest ionization potential is
   (a) F (b) Cl
   (c) I (d) At
2. The halide ion with the highest hydration energy is
   (a) F^- (b) Cl^-
   (c) I^- (d) At^-
3. The anhydride of $HClO_4$ is
   (a) ClO_4^- (b) Cl_2O_7
   (c) ClO_2 (d) ClO_3
4. Polymeric fluorocarbons tend to be
   (a) good oxidising agents
   (b) good reducing agents
   (c) corrosive to the skin
   (d) very unreactive
5. Choose the molecule which is not paramagnetic
   (a) ClO_2 (b) ClF_3
   (c) ClO_3 (d) BrO_2
6. Hypobromous acid is
   (a) HOBr (b) HOBrO
   (c) $HOBrO_2$ (d) $HOBrO_3$

7. Hydrofluoric acid is
   (a) a powerful oxidizing agent
   (b) a weak acid
   (c) a strong acid
   (d) a good reducing agent

8. Br_2 can be produced by
   (a) oxidizing Br^- by I_2
   (b) oxidizing Cl_2 by Br^-
   (c) oxidising Br^- by Cl_2
   (d) oxidizing I^- by Br^-

9. Which of the following illustrates "violation" of the octet rule ?
   (a) I_2 (b) ICl_3
   (c) $HClO_2$ (d) HOBr

10. Which one is least soluble in water ?
    (a) NaF (b) CaF_2
    (c) AgF (d) HF

11. Which one is most soluble in water ?
    (a) AgCl (b) AgBr
    (c) SrF_2 (d) $SrCl_2$

12. Which of the following is the weakest acid ?
    (a) $HClO_4$ (b) $HClO_3$
    (c) $HClO_2$ (d) HOCl

13. Which of the following is most powerful oxidising agent ?
    (a) F_2 (b) Cl_2
    (c) Br_2 (d) I_2

14. Which of the following exhibits the largest electrical conductivity in the liquid state ?
    (a) F_2 (b) Cl_2
    (c) Br_2 (d) I_2

15. Which one has the highest electronegativity ?
    (a) F (b) Cl
    (c) Br (d) I

16. The deep colour produced when iodine is dissolved in a solution of KI is due to the presence of
    (a) I_2 (b) I^-
    (c) I_3^- (d) I_2^-

17. Which of the following exhibits the highest bond energy ?
    (a) F_2 (b) Cl_2
    (c) Br_2 (d) I_2

18. "Chlorine-type" laundry bleaches are in reality aqueous solutions of
    (a) HOCl (b) $HClO_3$
    (c) $NaClO_3$ (d) NaOCl

19. The perchlorate ion is not often employed as an oxidizing agent because
    (a) it is not a strong one
    (b) it is not a fast one
    (c) it is too unstable
    (d) it causes HBr to disproportionate

20. Concentrated H_2SO_4 can be used to prepare HBr from NaBr, but it usually is not because
    (a) it oxidizes HBr
    (b) it reduces HBr
    (c) it reacts too slowly with NaBr
    (d) it causes the HBr to disproportionate

21. Which has the lowest boiling point ?
    (a) F_2 (b) Cl_2
    (c) Br_2 (d) I_2

22. Which of the following has a pyramidal structure ?
    (a) ClO_2 (b) ClO_2^-
    (c) ClO_3^- (d) ClO_4^-

23. Which of the following forms the most basic 0.1 M solution ?
    (a) NaCl (b) NaOCl
    (c) $NaClO_2$ (d) $NaClO_3$

24. Which one is the highest melting halide ?
    (a) NaCl (b) NaBr
    (c) NaF (d) NaI

25. Which one does not form its oxy acids ?
    (a) Fluorine (b) Bromine
    (c) Chlorine (d) Iodine

26. The colour of I_2 solution can be discharged by shaking with aqueous solution of
    (a) sulphur dioxide (b) sodium thiosulphate
    (c) sodium sulphite (d) sodium sulphate

27. In the reaction $3\ Br_2 + 6\ CO_3^{2-} + 3\ H_2O \rightarrow 5Br\text{-} \times BrO_3^{-1} + 6HCO_3^-$
    (a) bromine is oxidized and carbonate is reduced
    (b) bromine is reduced and water is oxidized
    (c) bromine is neither reduced nor oxidized
    (d) bromine is both reduced and oxidized

28. Bleaching powder is obtanied by the interaction of Cl_2 and
    (a) a dil. solution of $Ca(OH)_2$
    (b) conc. solution of $Ca(OH)_2$
    (c) dry CaO
    (d) dry slaked lime

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IMPORTANT INORGANIC CHEMICAL REACTIONS

1. *A red precipitate is obtained when KI is added to $HgCl_2$.* The precipitate dissolves in excess of KI.

$$HgCl_2 + 2KI \rightarrow \underset{\text{Red ppt.}}{HgI_2} + 2KCl$$

$$HgI_2 + 2KI \rightarrow \underset{\substack{\text{Colourless potassium}\\\text{tetraiodo mercurate}}}{K_2HgI_4}$$

2. *Iodine is soluble in KI.*

$$KI + I_2 \rightarrow \underset{\text{Pot. triodide.}}{KI_3}$$

3. *A violet colour appears in $CHCl_3$ layer on passing Cl_2 in KI solution*

$$2KI + Cl_2 \rightarrow 2KCl + I_2$$

$$I_2 + CHCl_3 \rightarrow \text{Violet}$$

4. *$CuSO_4$ is warmed with hypo solution.*

   $CuSO_4$ is first reduced and then dissolves in hypo.

$$2\,CuSO_4 + 2Na_2S_2O_3 \rightarrow Cu_2SO_4 + Na_2S_4O_6 + Na_2SO_4$$

$$Cu_2SO_4 + Na_2S_2O_3 \rightarrow Cu_2S_2O_3 + Na_2SO_4$$

$$2Cu_2S_2O_3 + 2Na_2S_2O_3 \rightarrow \underset{\text{soluble}}{Na_4\,[Cu_6\,(S_2O_3)_5]}$$

5. *Chlorine reacts with cold caustic soda solution* to give NaCl and NaClO.

$$2\,NaOH + Cl_2 \rightarrow NaCl + NaClO + H_2O$$

6. *Chlorine reacts with hot NaOH solution to give $NaClO_3$.*

$$3Cl_2 + 6NaOH \rightarrow NaClO_3 + 5NaCl + 3H_2O$$

7. *Yellow phosphorus reacts with NaOH solution* to give PH_3 (phosphine).

$$P_4+3NaOH+3H_2O \rightarrow 3NaH_2PO_2+PH_3$$

8. *$CuSO_4$ reacts with KI solution* to liberate I_2.

$$2CuSO_4+4KI \rightarrow Cu_2I_2+2K_2SO_4+I_2$$

9. *Stannous chloride precipitates out mercury, when added to mercuric chloride solution.*

$$2HgCl_2+SnCl_2 \rightarrow 2Hg+SnCl_4$$

10. *SO_2 is passed through solution of corrosive sublimate.* A white ppt of calomel (Hg_2Cl_2) is obtained

$$2HgCl_2+SO_2+2H_2O \rightarrow 2HgCl_2+2HCl+H_2SO_4$$

11. *SO_2 is passed into $FeCl_3$ solution* reduction of Fe^{3+} occurs

$$2FeCl_3+SO_2+2H_2O \rightarrow 2FeCl_2+2HCl+H_2SO_4$$

12. *SO_2 is passed through acidified $K_2Cr_2O_7$ soln.* Green soln. is obtained

$$K_2CrO_7+H_2SO_4+3SO_2 \rightarrow K_2SO_4+\underset{\text{green}}{Cr_2(SO_4)_3}+H_2O$$

13. *SO_2 is passed in bromine solution,* It gets decolourised

$$Br_2+2H_2O+SO_2 \rightarrow 2HBr+H_2SO_4$$

14. *H_2S reduces ferric chloride to ferous chloride*

$$2FeCl_3+H_2S \rightarrow 2FeCl_2+2HCl+S$$

15. *H_2S is passed through As^{3+} solution to form yellow precipitate of As_2S_3*

$$2AsCl_3+3H_2S \rightarrow \underset{\text{yellow}}{As_2S_3}+6HCl$$

16. *Na_2S reacts with sodium nitroprusside to give violet colour*

$$Na_2S+Na_2\,[Fe(NO)\,(CN)_5] \rightarrow \underset{\text{voilet complex}}{Na_3\,[Fe(O=N-S-Na)(CN)_5]}$$

17. *H_2O_2 oxidises PbS to $PbSO_4$*

$$PbS+4H_2O_2 \rightarrow PbSO_4+4H_2O$$

18. *Aqua regia dissolves gold*

$$HNO_3+3HCl \rightarrow 2H_2O+NOCl+2Cl$$

$$Au+3Cl \rightarrow AuCl_3$$

19. *Ozone reacts with K_2MnO_4 soln to give $KMnO_4$.*

$$2K_2MnO_4+H_2O+O_3 \rightarrow 2K\,MnO_4+2KOH+O_2$$

20. *HCl is added drop by drop to $KMnO_4$.* Cl_2 is liberated

$$2KMnO_4+16HCl \rightarrow 2KCl+2MnCl_2+8H_2O+5Cl_2$$

21. *Metallic tin is heated with conc HNO_3.* A white ppt is formed

$$Sn+4HNO_3 \rightarrow \underset{\text{white ppt}}{H_2SnO_3}+H_2O+4NO_2$$

22. *H_2S is passed through acidified $KMnO_4$ soln.* It gets decolourised

$$2KMnO_4+3H_2SO_4+6H_2S \rightarrow K_2SO_4+2MnSO_4+8H_2O+5S$$

23. *H_2O_2 oxidises acidified $K_4[Fe(CN)_6]$ to $K_3[Fe(CN)_6]$*

$$2K_4[Fe(CN)_6]+H_2SO_4+H_2O_2 \rightarrow 2K_3[Fe(CN)_6]+K_2SO_4+2H_2O$$

24. *H_2O_2 is added to KI solution.* I_2 is liberated

$$2KI+H_2O_2 \rightarrow 2KOH+I_2$$

25. *$Na_2S_2O_3$ is added to a mixture of $CuSO_4$ and KI soln.* White ppt of Cu_2I_2 is obtained

$$CuSO_4+2KI \rightarrow CuI_2+K_2SO_4$$
$$2CuI_2 \rightarrow Cu_2I_2+I_2$$
$$I_2+Na_2S_2O_3 \rightarrow 2NaI+Na_2S_4O_6$$

26. *Zinc chloride is treated with excess of NaOH solution.*

$$ZnCl_2+2NaOH \rightarrow \underset{\text{white ppt}}{Zn(OH)_2}+2NaCl$$
$$Zn(OH)_2+\underset{\text{excess}}{2NaOH} \rightarrow \underset{\text{soluble}}{Na_2ZnO_2}+2H_2O$$

27. *Magnesium bicarbonate is heated with milk of lime.* A white ppt is obtained

$$Mg(HCO_3)_2+Ca(OH)_2 \rightarrow MgCO_3+CaCO_3+2H_2O$$

28. *Excess NaOH is added to $AlCl_3$ solution.* A white ppt. soluble in excess is obtained

$$AlCl_3+3NaOH \rightarrow \underset{\text{white ppt}}{Al(OH)_3}+3NaCl$$
$$Al(OH)_3+NaOH \rightarrow \underset{\text{soluble}}{NaAlO_2}+2H_2O$$

29. *$K_2Cr_2O_7$ and NH_4Cl mixture is heated*; green residue is left.

$$K_2Cr_2O_7+2NH_4Cl \rightarrow (NH_4)_2Cr_2O_7+2KCl$$
$$(NH_4)_2Cr_2O_7 \rightarrow N_2+\underset{\text{green}}{Cr_2O_3}+4H_2O$$

30. *Sodium iodate reacts with $NaHSO_3$ solution.* I_2 is liberated

$$2NaIO_3+5NaHSO_3 \rightarrow 3NaHSO_4+2Na_2SO_4+H_2O+I_2$$

31. *Sodium bromide is heated with MnO_2 and conc H_2SO_4.* Brown vapours of bromine are evolved

$$2NaBr+MnO_2+3H_2SO_4 \rightarrow 2NaHSO_4+MnSO_4+H_2O+\underset{\text{Brown}}{Br_2}$$

32. *Silver oxide is heated with hydrogen peroxide.*

$$Ag_2O+H_2O_2 \rightarrow 2Ag+H_2O+O_2$$

33. *Sodium phosphate is heated with freshly prepared solution of yellow ammonium molybdate in the presence of conc.* HNO_3. A yellow ppt. is obtained

$$Na_3PO_4+12(NH_4)_2MoO_4+24HNO_3 \rightarrow 3NaNO_3 +21NH_4NO_3+\underset{\text{yellow ppt}}{(NH_4)_3PO_4.12MoO_3}+12H_2O$$

34. *Ammonia reacts with chlorine.*
    (i) When ammonia is in excess.
    $8NH_3+Cl_2 \rightarrow 6NH_4Cl+N_2$
    (ii) When chlorine is in excess.
    $NH_3+3Cl_2 \rightarrow \underset{\text{explosive}}{NCl_3}+3HCl$

35. *Chlorine is passed over dry slaked lime.* Bleaching powder is obtained.
    $Ca(OH)_2+Cl_2 \rightarrow CaOCl_2+H_2O$

36. *$AuCl_3$ is treated with $SnCl_2$ solution.* Violet coloured colloidal solution of gold is obtained.
    $2AuCl_3+3SnCl_2 \rightarrow 2Au+3SnCl_4$

37. *CaF_2, SiO_2 and conc. H_2SO_4 are heated together.* White fumes of HF formed further react to give H_2SiF_6 and waxy deposit of H_4SiO_4
    $CaF_2+H_2SO_4 \rightarrow CaSO_4+2HF$
    $SiO_2+4HF \rightarrow 2H_2O+SiF_4$
    $3SiF_4+4H_2O \rightarrow 2H_2SiF_6+H_4SiO_4$

38. *Ammonia is passed through Nessler's reagent.* Brown ppt. is obtained
    $HgCl_2+2KI \rightarrow HgI_2+2KCl$
    $HgI_2+2KI \rightarrow \underset{\text{colourless}}{K_2HgI_4}$

    When KOH is added to it, Nessler's reagent is obtained

    $$2K_2HgI_4+3KOH+NH_3 \rightarrow \underset{\text{brown ppt}}{H_2N-HgO-HOI}+7KI+H_2O$$

39. *Ammonia is passed over heated sodium.* Sodamide is formed.
    $2Na+2NH_3 \rightarrow 2NaNH_2+H_2$

40. *Oxalic acid is heated with $KMnO_4$ and dil. H_2SO_4.* $KMnO_4$ is decolourised with formation of CO_2.

$$2KMnO_4+3H_2SO_4+5H_2C_2O_4 \rightarrow K_2SO_4+2MnSO_4+8H_2O+10CO_2$$

41. *A mixture of NH_4Cl and $NaNO_3$ is heated.* Laughing gas is formed.

$$NaNO_3+NH_4Cl \rightarrow NH_4NO_3+NaCl$$

$$NH_4NO_3 \rightarrow \underset{\text{laughing gas}}{N_2O}+2H_2O$$

42. *NH_4OH is added to a solution of blue vitroil* Blue ppt. formed dissolves in excess to give blue solution.

$$CuSO_4+NH_4OH \rightarrow [Cu(NH_3)_4]SO_4+4H_2O$$

43. *NH_4OH is added to AgCl.* White ppt of AgCl dissolves

$$AgCl+NH_4OH \rightarrow [Ag(NH_3)_2]Cl+2H_2O$$

44. *KCN solution is added to $AgNO_3$ solution.* A white ppt. formed dissolves in excess .KCN to give colourless solution.

$$AgNO_3+KCN \rightarrow AgCN+KNO_3$$
$$AgCN+KCN \rightarrow K[Ag(CN)_2]$$

45. *NH_4OH is added to Mercury chloride.*
    (i) A black precipitate is obtained with Hg_2Cl_2

$$Hg_2Cl_2+2NH_4OH \rightarrow Hg+Hg(NH_2)Cl+NH_4Cl+2H_2O$$

    (ii) A white precipitate is formed with $HgCl_2$

$$HgCl_2+2NH_4OH \rightarrow Hg(NH_2)Cl+NH_4Cl+2H_2O$$

46. *Hypo is added to $AgNO_3$ solution.* A white ppt. obtained gets changed to yellow, brown and finally black due to formation of Ag_2S.

$$2AgNO_3+Na_2S_2O_3 \rightarrow \underset{\text{white ppt}}{Ag_2S_2O_3}+2NaNO_3$$

$$Ag_2S_2O_3+H_2O \rightarrow \underset{\text{black ppt}}{Ag_2S}+H_2SO_4$$

In concentrated hypo no ppt is formed as $Ag_2S_2O_3$ formed dissolves in hypo to give a colourless solution.

$$Ag_2S_2O_3+3Na_2S_2O_3 \rightarrow \underset{\text{colourless}}{2Na_3[Ag(S_2O_3)_2]}$$

47. *$Na_2S_2O_3$ is added to AgCl.* The white ppt dissolves.

$$AgCl+2Na_2S_2O_3 \rightarrow Na_3[Ag(S_2O_3)_2]+NaCl$$

48. *Zinc sulphate reacts with NaOH* to give a white ppt which dissolves in excess of NaOH

$$ZnSO_4+2NaOH \rightarrow \underset{\text{white ppt}}{Zn(OH)_2}+Na_2SO_4$$

$$Zn(OH)_2+2NaOH \rightarrow \underset{\text{soluble}}{Na_2ZnO_2}+2H_2O$$

49. *A mixture of NaCl and $K_2Cr_2O_7$ is heated with conc H_2SO_4.* Red vapours of chromyl chloride (CrO_2Cl_2) are evolved

$$4NaCl+K_2Cr_2O_7+3H_2SO_4 \rightarrow 2CrO_2Cl_2+2Na_2SO_4 +K_2SO_4+3H_2O$$

50. *Aluminium powder is heated with NaOH.* Hydrogen is evolved

$$2Al+2NaOH+2H_2O \rightarrow 2NaAlO_2+H_2$$

51. *KBr is heated with conc H_2SO_4*, Br_2 is evolved

$$2KBr+2H_2SO_4 \rightarrow K_2SO_4+2H_2O+SO_2+Br_2$$

52. *AlN is heated with water.* Ammonia is given out.

$$AlN+3H_2O \rightarrow \underset{\text{white ppt}}{Al(OH)_3}+NH_3$$

53. *AgCl is fused with Na_2CO_3.* Metallic Silver is obtained.

$$4AgCl+2Na_2CO_3 \rightarrow 4Ag+4NaCl+2CO_2+O_2$$

54. *SO_2 is passed through a solution of H_2S.* Colloidal sulphur is formed.

$$SO_2+2H_2S \rightarrow 2H_2O+3S$$

55. *CO_2 is passed through a saturated solution of Na_2CO_3.*

$$Na_2CO_3+H_2O+CO_2 \rightarrow 2NaHCO_3$$

PART III

Organic Chemistry

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INTRODUCTION TO ORGANIC CHEMISTRY

1. An isomer of ethanol is
   (a) dimethyl ether (b) diethyl ether
   (c) ethylene glycol (d) methanol

2. In CCl_4 the four valencies of carbon are directed towards the corners of a
   (a) cube (b) hexagon
   (c) prism (d) tetrahedron

3. Tetrahedral nature of bonding in carbon atom was first shown by
   (a) Wohler (b) Vant Hoff and Le Bel
   (c) Lewis (d) Kekule

4. The general formula $(RCO)_2O$ represents
   (a) an ether (b) ketone
   (c) an ester (d) an acid anhydride

5. The main source of most organic compounds is
   (a) methane (b) coal gas
   (c) petroleum (d) none of the above

6. How many chain isomers can be obtained from the alkane C_6H_{14} ?
   (a) 4 (b) 5
   (c) 6 (d) 7

7. The isomers must have the same
   (a) structural formula
   (b) molecular formula
   (c) chemical properties
   (d) physical properties

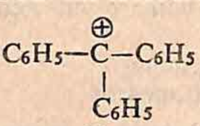
8. An sp^3 hybrid orbital possesses
   (a) $\frac{1}{4}$th of s-character
   (b) $\frac{1}{2}$ of s-character
   (c) $\frac{2}{3}$rd of s-character
   (d) $\frac{3}{4}$th of s-character

9. Which has the longest bond length ?
   (a) C≡C (b) C=C
   (c) C−C (d) All the above

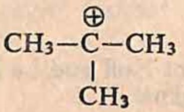
10. Which concept best explains the fact that *o*-nitrophenol is more volatile than *p*-nitrophenol ?
   (a) Resonance
   (b) Hyper conjugation
   (c) Hydrogen bonding
   (d) Steric hindrance

11. The number of conformations for ethane are
   (a) 1 (b) 2
   (c) 3 (d) Infinite

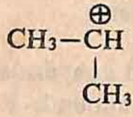
12. Pick out the most stable carbonium ion

(a) 

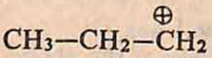
$C_6H_5-\underset{C_6H_5}{\overset{\oplus}{C}}-C_6H_5$

(b) 

$CH_3-\underset{CH_3}{\overset{\oplus}{C}}-CH_3$

(c) 

$CH_3-\underset{CH_3}{\overset{\oplus}{CH}}$

(d) 

$CH_3-CH_2-\overset{\oplus}{CH_2}$

13. Which of these is not a substitution reaction ?
   (a) $CH_4+Cl_2 \rightarrow CH_3Cl+HCl$
   (b) $C_2H_6+Cl_2 \rightarrow C_2H_5Cl+HCl$
   (c) $CHCl_3+Cl_2 \rightarrow CCl_4+HCl$
   (d) $C_2H_4+Cl_2 \rightarrow C_2H_4Cl_2$

14. Which of the following are isomers ?
   (a) Methyl alcohol and dimethyl ether
   (b) Ethyl alcohol and dimethyl ether
   (c) Acetone and acetaldehyde
   (d) Propanoic acid and propanone

15. The reaction

   $H_2O+C_{12}H_{22}O_{11} \rightarrow 4CO_2+4C_2H_5OH$ is an example of
   (a) fermentation (b) esterification
   (c) saponification (d) polymerization

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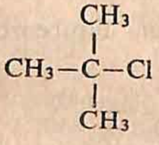
REACTION MECHANISM

1. Organic reactions are generally characterized by
   (a) slow reaction velocities
   (b) formation of zwitter ions
   (c) complete disintegration of the reacting molecules
   (d) polymerization of reactants
2. Peroxide initiated polymerizations occur in a
   (a) natural process syntheses
   (b) isomeric saponification
   (d) free-radical chain propagation
   (d) hydrocarbon combustion.
3. The yield of organic synthesis reactions is often less than 100% because of
   (a) polymerisation
   (b) hydrolysis
   (c) free radical formation
   (d) side reactions.
4. Which compound reacts most rapidly by S_N1 mechanism ?
   (a) CH_3Cl
   (b) $CH_3-CH=CH-Cl$
   (c) $Cl-CH_2-CH=CH_2$
   (d) 
   $CH_3-C(CH_3)_2-Cl$
5. The mechanism of dehydration of alcohol to give an alkene involves
   (a) carbanion formation
   (b) carbonium ion formation
   (c) free radical formation
   (d) hydride ion transfer
6. The effect caused by resonance is known as
   (a) electronic effect (b) inductive effect
   (c) mesomeric effect (d) polarisation

7. Inductive effect is operative in
   (a) covalent bonds
   (b) ionic bonds
   (c) polar covalent bonds
   (d) none of these

8. Electromeric effect is
   (a) permanent effect (b) resonance effect
   (c) temporary effect (d) none of these

9. Which of the following is an +I group?
   (a) Alkyl (b) Halogen
   (c) Phenyl (d) Nitro

10. The combination of *t*-butyl carbonium ion with hydroxy anion takes place by which of the following mechanism?
    (a) S_N1 (b) S_N2
    (c) S_E1 (d) S_E2

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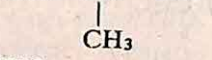
HYDROCARBONS

1. Nitrosobenzene can be isolated from nitrobenzene under
   (a) metal and acid
   (b) zinc dust and NH_4Cl
   (c) alkaline sodium arsenite
   (d) none

2. Solid CH_4 is
   (a) molecular solid
   (b) covalent solid
   (c) ionic solid
   (d) does not exist

3. Benzene reacts with CH_3COCl in the presence of $AlCl_3$ to give
   (a) C_6H_5Cl (b) $C_6H_5CH_3$
   (c) C_6H_5COCl (d) $C_6H_5COCH_3$

4. The correct chemical name for



$$\mathrm{CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_3}$$

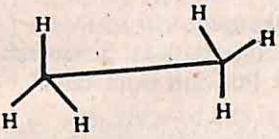
would be

   (a) butane (b) 2-methyl propane
   (c) isopropyl methane (d) dimethyl ethane

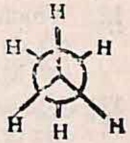
5. Formation of alkane by action of Zn on alkyl halide is called
   (a) Frankland reaction
   (b) Wurtz reaction
   (c) Cannizaro reaction
   (d) Kolbe's reaction

6. In the following structures, which two forms are staggered conformations of ethane ?

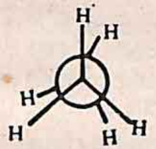
(i)



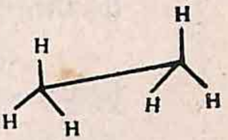
(ii)



(iii)



(iv)

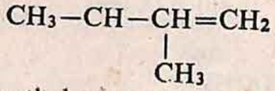


   (a) 1 and 4 (b) 2 and 3
   (c) 1 and 2 (d) 1 and 3

7. A liquid hydrocarbon is converted into a mixture of gaseous hydrocarbons by
   (a) cracking (b) hydrolysis
   (c) oxidation (d) reduction

8. Alkenes undergo
   (a) addition reactions
   (b) substitution reactions
   (c) both (d) none

9. The IUPAC name of the compound represented by the formula

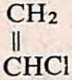


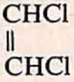
$$\mathrm{CH_3-\underset{\underset{CH_3}{|}}{CH}-CH{=}CH_2}$$

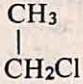
is

   (a) 2-methyl pentene
   (b) 4-meth yl pentene
   (c) 4-methyl-1-pentene
   (d) 1-hexene

10. C_2H_2 reacts with HCl to produce

(a) 
$\begin{array}{c}CH_2\\ \|\\ CHCl\end{array}$

(b) 
$\begin{array}{c}CHCl\\ \|\\ CHCl\end{array}$

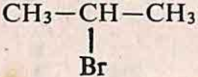
(c) 
$\begin{array}{c}CH_3\\ |\\ CH_2Cl\end{array}$

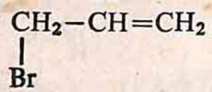
(d) none

11. The negative part of the addendum adds on to the carbon atom joined to the least number of hydrogen atoms. The statement is called
   (a) Markownikoffs' rule
   (b) Peroxide effect
   (c) Baeyer's strain theory
   (d) Thiele's theory

12. Which one is not found in alkenes ?
   (a) Chain isomerism (b) Geometrical isomerism
   (c) Mesomerism (d) Position isomerism

13. $CH_3-CH=CH_2+HBr\rightarrow$
   the product formed is
   (a) $CH_3-CH_2-CH_2-Br$

(b) 
$\begin{array}{l}CH_3-CH-CH_3\\ \qquad\quad |\\ \qquad\quad Br\end{array}$

(c) 
$\begin{array}{l}CH_2-CH=CH_2\\ |\\ Br\end{array}$

   (d) $CH_2=C=CH_2$

14. Ethylene dichloride and ethylidene chloride are isomeric compounds. Identify the statement which is not applicable. Both of them
   (a) react with alcoholic potash
   (b) react with aqueous potash and give the same product
   (c) are dihalides
   (d) answer Beilstein's test

15. Identify Z in the following series

$$\text{Ethanol}\xrightarrow{PBr_3}X\xrightarrow{\text{Alc.KOH}}Y\xrightarrow[\text{(ii) }H_2O\text{, heat}]{\text{(i) }H_2SO_4\text{/nor. temp.}}Z$$

   (a) $CH_2=CH_2$
   (b) CH_3-CH_2-OH
   (c) $CH_3-CH_2-O-CH_2CH_3$
   (d) $CH_3-CH_2-O-SO_3H$

16. The polythene is a polymer of
   (a) ethylene (b) acetone
   (c) propylene (d) butadiene

17. In an industrial process coke is heated with quick lime in an electric furnance, and the cooled product is then treated with water to produce
    (a) acetylene (b) methane
    (c) oxygen (d) iron

18. When acetylene is passed through warm dilute sulphuric acid in presence of mercuric sulphate,
    (a) ethyl alcohol is formed
    (b) acetaldehyde is formed
    (c) acetone is formed
    (d) carbide of mercury is formed

19. Which of the following reagents distinguishes ethylene from acetylene?
    (a) Aqueous alkaline $KMnO_4$
    (b) Chlorine dissolved in CCl_4
    (c) Ammoniacal cuprous chloride
    (d) Conc. H_2SO_4

20. When a mixture of CO, C_2H_4 and C_2H_2 is passed through ammoniacal cuprous chloride solution,
    (a) acetylene and CO are absorbed
    (b) CO is absorbed
    (c) C_2H_4 is absorbed
    (d) nothing happens

21. General formula of alkynes is
    (a) C_nH_{2n-2} (b) C_nH_{2n}
    (c) CnH_{2+n} (d) C_nH_{2n+1}

22. What piosonous gas is present in the exhaust fumes of car ?
    (a) Methane
    (b) Carbon dioxide
    (c) Acetylene
    (d) Hydrochloric acid

23. The resonance between two structures I and II is represnted by
    (a) I=II (b) $I \rightleftharpoons II$
    (c) $I \longleftrightarrow II$ (d) $I \rightarrow II$

24. The number of xylene isomers is
    (a) 2 (b) 3
    (c) 4 (d) 5

25. The number of π-electrons in cycloheptatrienyl anion is
    (a) 5 (b) 6
    (c) 7 (d) 8

26. Structure of benzene is
(a) diagonal (b) planar
(c) pyramidal (d) tetrahedral

27. Benzene was discovered by
(a) Dalton (b) Faraday
(c) Priestley (d) Ramsay

28. "Gammexane" an insecticide is a formulation based on
(a) D.D.T. (b) BHC
(c) C_2Cl_6 (d) CCl_3CHO

29. The biological oxidation of benzene carried out in the body of dog produces
(a) cinnamic acid (b) maleic acid
(c) acrylic acid (d) muconic acid

30. On aromatisation *n*-hexane produces
(a) benzene (b) toluene
(c) xylene (d) none of these

31. The directive influence of groups is explained better by
(a) Crum-Brown and Gibson rule
(b) Hammick-Illingworth rule
(c) Vorlander rule
(d) all the above

32. Which of the following is strongly acidic ?
(a) m-bromophenol (b) m-cresol
(c) m-nitrophenol (d) phenol

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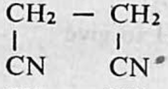
HALOGEN COMPOUNDS

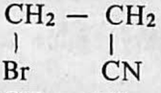
1. What happens if CCl_4 is treated with $AgNO_3$?
(a) A white ppt. of AgCl will form
(b) NO_2 will be evolved
(c) CCl_4 will dissolve in $AgNO_3$
(d) Nothing will happen

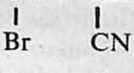
2. Which one of the following compounds does not react with bromine ?
   (a) Ethylamine (b) Propene
   (c) Phenol (d) Chloroform
3. Which of the following alkyl halides is used as a methylating agent?
   (a) C_2H_5Cl (b) C_2H_5Br
   (c) C_2H_5I (d) CH_3I
4. Which of the following processes does not occur during the formation of $CHCl_3$ from C_2H_5OH and bleaching powder ?
   (a) Hydrolysis (b) Oxidation
   (c) Reduction (d) Chlorination
5. A sample of chloroform before being used as an anaesthetic is tested by
   (a) $AgNO_3$ solution
   (b) $AgNO_3$ solution after boiling with KOH
   (c) Fehlings solution
   (d) Ammoniacal CuCl
6. Identify Z in the following series

$$C_2H_5I \xrightarrow[\text{KOH}]{\text{Alcoholic}} X \xrightarrow{Br_2} Y \xrightarrow{KCN} Z$$

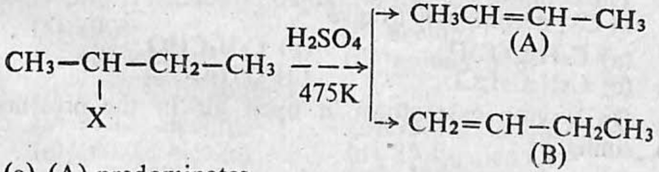
(a) CH_3-CH_2-CN

(b)

$CH_2(CN)-CH_2(CN)$

(c)

$CH_2(Br)-CH_2(CN)$

(d)

$CH(Br)=CH(CN)$

7. For the reaction


$$CH_3-\underset{X}{CH}-CH_2-CH_3 \xrightarrow[475K]{H_2SO_4} \begin{cases} CH_3CH=CH-CH_3 \ (A) \\ CH_2=CH-CH_2CH_3 \ (B) \end{cases}$$

(a) (A) predominates
(b) (B) predominates
(c) Both (A) and (B) are formed in equal amounts
(d) the product ratio is dependent on the halogen X

8. Trichloromethane is obtained
   (a) by the action of chlorine on iodoform
   (b) by the action of chlorine on acetaldehyde
   (c) by adding chlorine to ethylene
   (d) by the action of chlorine and alkali on acetone
9. When a solution of $AgNO_3$ is added into pure CCl_4
   (a) a curdy white precipitate, soluble in ammonia is formed
   (b) chlorine is liberated
   (c) a curdy white precipitate, insoluble in ammonia is formed
   (d) no precipitate is formed
10. The starting substance for the preparation of CHI_3 is any of the following except
   (a) C_2H_5OH
   (b) CH_3CHO
   (c) CH_3OH
   (d) CH_3COCH_3
11. The dichlorobenzene which has two chlorine atoms in the molecule separated by two CH groups is
   (a) orthodichlorobenzene
   (b) metadichlorobezene
   (c) mesodichlorobezene
   (d) paradichlorobezene
12. The active electrophile in the nitration of aromatic ring is
   (a) NO_2^-
   (b) NO^+
   (c) NO_2^+
   (d) HNO_2^+
13. Ethyl chloride reacts with alc. KOH to give
   (a) C_2H_5OH
   (b) C_2H_6
   (c) C_2H_2
   (d) C_2H_4
14. On heating chloroform with a primary amine and KOH, we get
   (a) bad nectar-like smell
   (b) rose odour smell
   (c) sour almond smell
   (d) sour oil of winter green like smell
15. The complex formed by oxidation of toluene with CrO_2Cl_2 in CS_2 decomposes to give
   (a) C_6H_5COOH
   (b) C_6H_5CHO
   (c) $C_5H_5CH_2Cl$
   (d) C_6H_5COCl
16. On leaving chloroform in open air in the presence of sunlight
   (a) explosion takes place
   (b) poisonous phosgene gas is formed
   (c) polymerisation takes place
   (d) no reaction takes place

17. Which one of the following undergoes free radical chlorination most easily?
    (a) Ethyl benzene (b) Isobutane
    (c) Neopentane (d) n-pentane
18. The least reactive towards bromine is
    (a) anisole (b) phenol
    (c) chlorobenzene (d) nitrobenzene
19. The Sandmeyer reaction is used to prepare
    (a) phenols (b) diazo compounds
    (c) halo compounds (d) nitro compounds
20. For substitution reactions, nuclear halogen atoms are
    (a) more reactive than alkyl halides
    (b) less reactive than alkyl halides
    (c) as reactive as alkyl halides
    (d) none of the above is correct
21. Alcoholic silver nitrate solution gives a precipitate with
    (a) trans-dichloroethylene
    (b) cis-dichloroethylene
    (c) chlorobenzene
    (d) benzyl chloride

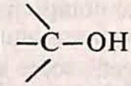
34

ALCOHOLS AND PHENOLS

1. The action of nitrous acid on ethyl amine gives
   (a) ethane (b) ammonia
   (c) ethylalcohol (d) nitroethane
2. Isopropyl acohol on oxidation forms
   (a) ether (b) acetone
   (c) ethylene (d) acetaldehyde
3 Rectified spirit contains
   (a) 95.6% alcohol (b) 75.0% alcohol
   (c) 100.0% alcohol (d) 85.4% alcohol
4. Alcoholic fermentation is brought out by the action of
   (a) yeast (b) CO_2
   (c) O_2 (d) CO

5. What is the end product in the process of fermentation ?
(a) Methyl alcohol (b) Ethanol
(c) CH_3CHO (d) Ethylene

6. Which is an isomer of ethanol?
(a) CH_3OH (b) CH_3OCH_3
(c) $C_2H_3OC_2H_5$ (d) C_6H_5OH

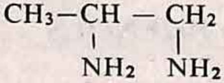
7. The characteristic grouping of secondary alcohol is
(a) $-CH_2OH$ (b) $-CHOH$
(c)  (d) $-COOH$

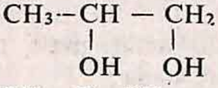
8. Glycerine is a
(a) secondary alcohol (b) tertiary alcohol
(c) trihydric alcohol (d) ester

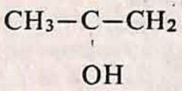
9. Which one is not the characteristic of the alcohols ?
(a) Their boiling points rise fairly uniformly with a rise in molecular weight
(b) Lower members have a pleasant smell but burning taste and the higher ones are odourless and tasteless
(c) These are lighter than water
(d) Lower members are insoluble in water and organic solvents but solubility increases with increase in molecular weight

10. Identify Z in the following series

$$CH_3-CH_2-CH_2OH \xrightarrow[160-180]{\text{Conc } H_2SO_4} X \xrightarrow{Br_2} Y \xrightarrow[\text{(ii) } NaNH_2]{\text{(i) Alc. KOH}} Z$$

(a) 
$CH_3-\underset{NH_2}{\underset{|}{CH}}-\underset{NH_2}{\underset{|}{CH_2}}$

(b) 
$CH_3-\underset{OH}{\underset{|}{CH}}-\underset{OH}{\underset{|}{CH_2}}$

(c) 
$CH_3-\underset{OH}{\underset{|}{C}}-CH_2$

(d) $CH_3-CH=CH_2$

11. For the reaction

$$C_2H_5OH+HX \xrightarrow{Zn X_2} C_2H_5X+H_2O$$

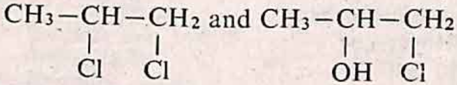
the order of reactivity is
(a) HBr>HI>HCl (b) HI>HCl>HBr
(c) HI>HBr>HCl (d) HCl>HBr>HI

12. In the dehydration of ethyl alcohol to ethylene with conc. H_2SO_4,
    (a) carbonium ions are involved
    (b) carbanions are involved
    (c) sulphuric acid acts as an electrophile
    (d) none of the above

13. Identify 'Z' in

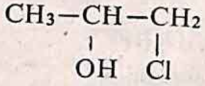
$$CH_3CH_2CH_2Br \xrightarrow{Ag,\ NaOH} X \xrightarrow[heat]{Al_2O_3} Y \xrightarrow{Cl_2/H_2O} Z$$

(a) Mixture of



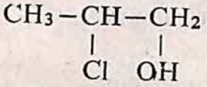
$CH_3-\underset{Cl}{CH}-\underset{Cl}{CH_2}$ and $CH_3-\underset{OH}{CH}-\underset{Cl}{CH_2}$

(b)



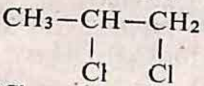
$CH_3-\underset{OH}{CH}-\underset{Cl}{CH_2}$

(c)



$CH_3-\underset{Cl}{CH}-\underset{OH}{CH_2}$

(d)



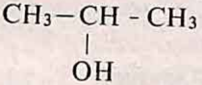
$CH_3-\underset{Cl}{CH}-\underset{Cl}{CH_2}$

14. $Z \xrightarrow{PCl_5} X \xrightarrow{Alc.\ KOH} Y \xrightarrow[\text{(ii) } H_2O\text{, boil}]{\text{(i) Conc } H_2SO_4} Z$

Z is

(a) $CH_3-CH_2-CH_2-OH$

(b)



$CH_3-\underset{OH}{CH}-CH_3$

(c) $(CH_3-CH_2)_3\,C-OH$

(d) $CH_3-CH=CH_2$

15. IUPAC name of $(C_2H_5)_2CHCH_2OH$ is
    (a) 2-ethyl butanol-1
    (b) 2-methyl pentanol-1
    (c) 2-ethyl pentanol-1
    (d) 3-ethyl butanol-1

16. A product formed by the reaction of sodium with ethanol is
    (a) H_2O (b) $NaOH$
    (c) NaH (d) H_2

17. Which of the following alcohols is least soluble in water ?
    (a) CH_3OH (b) C_3H_7OH
    (c) $C_6H_{13}OH$ (d) $C_{10}H_{21}OH$

18. Which of the following is strongest reducing agent ?
(a) C_3H_8 (b) C_3H_7OH
(c) C_2H_5CHO (d) CH_3COCH_3

19. Lucas reagent is
(a) P_4, I_2 and $AgNO_2$
(b) alkaline $KMnO_4$
(c) conc HCl and $ZnCl_2$
(d) hot reduced copper

20. Primary, secondary and tertiary alcohols may be distinguished by using
(a) Fehling's solution test
(b) Victor Meyer test
(c) Hofmann test
(d) Beilstein test

21. Glycerine on heating with $Ba(OH)_2$ gives
(a) methyl amine (b) acetamide
(c) acetic acid (d) barium acetate

22. Diketopiperazine is obtained by heating
(a) ammonium acetate (b) glycine
(c) methyl amine (d) propionic acid

23. The number of structural isomers for C_4H_9OH is
(a) 3 (b) 4
(c) 5 (d) 6

24. On heating glycerol with oxalic acid, we get
(a) formic acid
(b) tartaric acid
(c) alkyl alcohol
(d) allyl alcohol and formic acid

25. Glycerol when heated with $KHSO_4$ gives
(a) acrolein (b) allyl alcohol
(c) glyceraldehyde (d) none of the above

26. Which one is obtained by oxidation of glycerol with bismuth nitrate ?
(a) Glyceric acid
(b) Glyceric acid and tartronic acid
(c) Mesoxalic acid
(d) Glyceraldehyde and dihydroxy acetone

27. In cold countries glycerol is added to water in car radiators as it helps to
(a) bring down the specific heat of water
(b) lower the freezing point
(c) reduce the viscocity
(d) make water a better lubricant

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ALDEHYDES AND KETONES (CARBONYL COMPOUNDS)

1. Aldehydes may be distinguished from ketones by the use of
   - (a) conc H_2SO_4
   - (b) Grignard's reagent
   - (c) pyrogallol
   - (d) Fehlings solution
2. An aldehyde on oxidation gives
   - (a) an alcohol
   - (b) a ketone
   - (c) an acid
   - (d) an amine
3. On heating glycerol with cone H_2SO_4 a compound is obtained which has a bad odour, the compound is
   - (a) glycerol sulphate
   - (b) formic acid
   - (c) allyl alcohol
   - (d) acrolein
4. Phenol is heated with CCl_4 and alcoholic KOH, when salicylaldehyde is produced. This reaction is known as
   - (a) Friedel-Crafts reaction
   - (b) Reimer-Tiemann reaction
   - (c) Rosenmund's reaction
   - (d) Sommelet reaction
5. Formalin is an aqueous solution of
   - (a) formic acid
   - (b) formaldehyde
   - (c) fluorescein
   - (d) furfuraldehyde
6. If formaldehyde and KOH are heated we get
   - (a) acetylene
   - (b) methane
   - (c) methanol
   - (d) ethyl acetate
7. Which compound undergoes iodoform reaction ?
   - (a) HCHO
   - (b) CH_3CHO
   - (c) CH_3OH
   - (d) $CH_2ClCOOH$
8. A compound 'A' has a molecular formula C_2Cl_3OH. It reduces Fehlings solution and on oxidation gives a monocarboxylic and B. A is obtained by action of chlorine on ethanol. A is
   - (a) chloral
   - (b) $CHCl_3$
   - (c) CH_3Cl
   - (d) $CH_2ClCOOH$

9. When calcium acetate is heated with calcium formate, the product formed is
   (a) CH_3COCH_3
   (b) 2 CH_3CHO
   (c) $HCHO + CaCO_3$
   (d) $CH_3CHO + CaCO_3$

10. The compound formed on heating formaldehyde with ammonia is
    (a) methylamine
    (b) aminoformaldehyde
    (c) hexamethylenetetramine
    (d) formalin

11. Identify Z in the following series

$$\begin{matrix} CH_2 \\ \| \\ CH_2 \end{matrix} \xrightarrow{HBr} X \xrightarrow{\text{Hydrolysis}} Y \xrightarrow[I_2 \text{ Excess}]{Na_2CO_3} Z$$

    (a) C_2H_5I (b) C_2H_5OH
    (c) CHI_3 (d) CH_3CHO

12. Urotropin is formed by the action of ammonia on
    (a) $CH_3-CO-CH_3$ (b) CH_3CHO
    (c) $HCHO$ (d) C_6H_5CHO

13. Which of the following compounds reduces a solution of $AgNO_3$ in ammonia to give silver ?
    (a) Diethyl ether
    (b) Benzene
    (c) Ethyl alcohol
    (d) Acetaldehyde

14. The catalytic reduction of acetaldehyde by hydrogen yields
    (a) ethanol (b) methanol
    (c) acetic acid (d) acetone

15. Williamson's synthesis is an important means of preparing
    (a) alkyl halides (b) ketones
    (c) higher alkynes (d) mixed ethers

16. The reagent that reacts easily with both acetaldehyde and acetone is
    (a) Fehlings solution
    (b) Grignard's reagent
    (c) Schiff's reagent
    (d) Tollen's reagent

17. Fehlings solution is
    (a) ammoniacal $FeSO_4$
    (b) $H_2O_2 + FeSO_4$
    (c) $H_2O_2 + CuSO_4$
    (d) alkaline $CuSO_4$ stabilised by Rochelle salt

18. Aldehydes are distinguished from ketones by using
    (a) Schiff's reagent (b) Conc. H_2SO_4
    (c) only ZnO (d) resorcinol

19. Schiff's reagent is
    (a) ammoniacal silver nitrate
    (b) ammoniacal cuprous chloride
    (c) rosaniline solution in water decolorised by SO_2
    (d) none of the above

20. When two molecules of HCHO react with NaOH giving CH_3OH and CH_3COONa, it is known as
    (a) Fischer's reaction
    (b) Claisen's reaction
    (c) Cannizzaro's reaction
    (d) Wurtz reaction

21. Cannizzaro's reaction is given by
    (a) C_6H_5CHO (b) $C_6H_5COCH_3$
    (c) C_6H_5COOH (d) none of the above

22. On refluxing benzaldehyde with alcoholic KCN, we get
    (a) benzoin (b) phenyl cyanide
    (c) phenyl isocyanate (d) phenyl cyanate

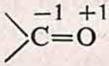
23. When benzaldehyde condenses with acetaldehyde in the presence of dilute alkali to form cinnamaldehyde, the reaction is called
    (a) Claisen condensation
    (b) Etard reaction
    (c) Houben-Hoesch reaction
    (d) Perkin reaction

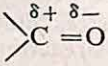
24. The preparation of benzaldehyde by refluxing benzyl chloride with hexamethylenetetramine followed by acidification and steam distillation is known as
    (a) Etard reaction (b) Rosenmund's reaction
    (c) Stephen reaction (d) Sommealet reaction

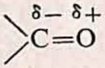
25. When benzaldehyde reacts with malonic acid in ethanolic ammonia in presence of pyridine to form cinnamic acid. The reaction is known as
    (a) Claisen-Schmidt reaction
    (b) Knoevenagel reaction
    (c) Wittig reaction
    (d) Schiffs' reaction

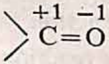
26. When Benzyl chloride reacts with lead nitrate it gives
    (a) C_6H_5CHO (b) C_6H_5COOH
    (c) $C_6H_5CH_2OH$ (d) $C_6H_5COCH_3$

27. B.P. of acetone is
    (a) 100°C (b) 60°C
    (b) 56°C (d) 90°C
28. In the reaction of phenyl hydrazine with acetone
    (a) acetone acts as a nucleophile
    (b) substitution takes place
    (c) phenylhydrazine acts as a nucleophile
    (d) addition takes place
29. Which of the following represents the correct charge distribution an the carbonyl group ?

(a) 

(b) 

(c) 

(d) 

36

ETHERS

1. Williamson's synthesis is used to prepare
    (a) acetone (d) P.V.C.
    (c) bakelite (d) diethylether
2. Diethylether absorbs oxygen to form
    (a) red coloured sweet smelling compound
    (b) acetic acid
    (c) ether suboxide
    (d) ether peroxide
3. Diethyl ether is formed when bromoethane is heated with
    (a) ethanol (b) sodium in ethanol
    (c) sodium in dry ether (d) HI
4. The reaction, in which an alkyl halide reacts with sodium alkoxide to produce ether, is known as
    (a) hydrolysis
    (b) Kolbe's reaction
    (c) Williamson's synthesis
    (d) Wurtz reaction

5. On treating ether with acidified $K_2Cr_2O_7$, we get
   (a) ethyl alcohol (b) ethyl acetate
   (c) acetic acid (d) acetaldehyde

6. According to Lewis concept, ethers behave as
   (a) acid (b) base
   (c) neutral (d) none of the above

7. Diethylether reacts with HI to give
   (a) ethyl alcohol
   (b) ethyl iodide
   (c) ethyl alcohol and ethyl iodide
   (d) none of these

8. Ether can be freed from peroxide on shaking with
   (a) ferrous salt solution
   (b) ferric salt solution
   (c) copper sulphate solution
   (d) none of these

9. On heating ethyl ether to 400°C in the presence of Al_2O_3, we get
   (a) acetylene (b) ethylene
   (c) ethane (d) ethyl alcohol

10. On heating C_2H_5I with Ag_2O we get
    (a) C_2H_5OH (b) $C_2H_5OC_2H_5$
    (c) both of these (c) none of the above

37

CARBOXYLIC ACIDS

1. The reaction of formic acid with concentrated H_2SO_4 gives
   (a) CH_3COOH (b) HCHO
   (c) CO_2 (d) CO

2. The acid present in vinegar is
   (a) CH_3COOH (b) HCl
   (c) H_2SO_4 (d) HNO_3

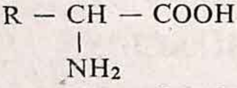
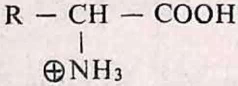
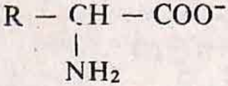
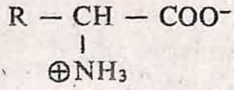
3. Which is formed when sodium phenoxide is heated with ethyl iodide ?
   (a) Phenetole (b) Phenol
   (c) Ethyl phenyl alcohol (d) none of the above

4. Name the compound 'C' in the following
   $CH_3COOH \xrightarrow{NH_3} A \xrightarrow{\Delta} B \xrightarrow{P_2O_5} C$
   (a) CH_4 (b) CH_3OH
   (c) acetonitrile (d) CH_3COONH_4

5. Formic acid and acetic acid may be distinguished by reaction with
   (a) sodium
   (b) dil. acid permanganate
   (c) 2, 4 dinitrophenyl hydrazine reagent
   (d) sodium ethoxide

6. Identify the product Z in the series
   $CH_3CN \xrightarrow{Na/C_2H_5OH} X \xrightarrow{HNO_2} Y \xrightarrow{\text{Tollen's reagent}} Z$
   (a) CH_3CHO
   (b) CH_3CONH_2
   (c) CH_3COOH
   (d) $CH_3CH_2NH_2OH$

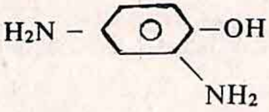
7. The relation of isoelectric point for an amino acid to solubitity is that
   (a) the two are not related
   (b) an amino acid is least soluble at isoelectric point
   (c) an amino acid has the maximum solubitity at isoelectric point
   (d) solubilities of only some acids depend on it

8. At the isoelectric point for an amino acid the species present is
   (a) 
   $R-\underset{NH_2}{\underset{|}{CH}}-COOH$
   (b) 
   $R-\underset{\oplus NH_3}{\underset{|}{CH}}-COOH$
   (c) 
   $R-\underset{NH_2}{\underset{|}{CH}}-COO^-$
   (d) 
   $R-\underset{\oplus NH_3}{\underset{|}{CH}}-COO^-$

9. Which one will liberate CO_2 from $NaHCO_3$?

(a) Carbolic acid

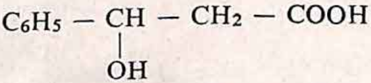
(b) Picric acid

(c) 

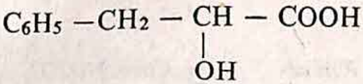
(d) none of the above

10. Identify 'Z'

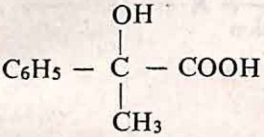
$$Z \xrightarrow{\text{dehydration}} C_6H_5-CH=CH-COOH$$

(a) 

$C_6H_5-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2-COOH$

(b) 

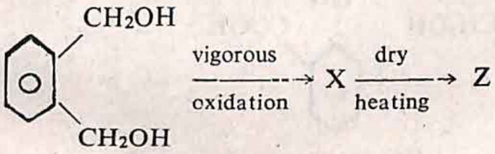
$C_6H_5-CH_2-\underset{\displaystyle OH}{\underset{|}{CH}}-COOH$

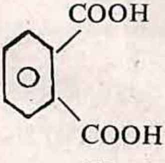
(c) 

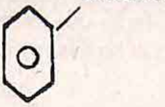
$C_6H_5-\overset{\displaystyle OH}{\overset{|}{\underset{\displaystyle CH_3}{\underset{|}{C}}}}-COOH$

(d) none of the above

11. Identify 'Z' in



(a) 

(b) 

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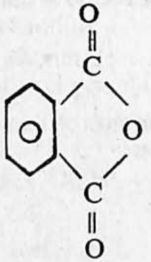
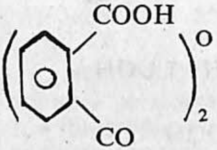
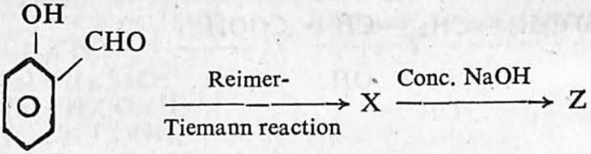


(d)



12. Identify 'Z' in



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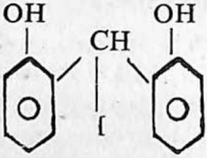

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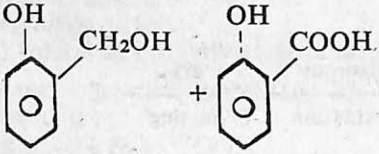

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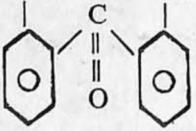

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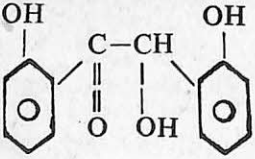

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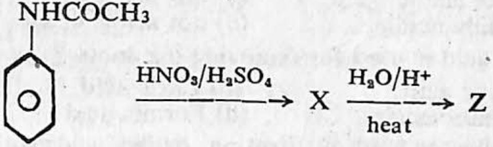

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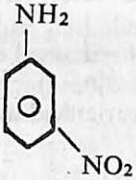

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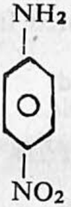

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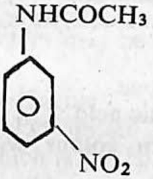

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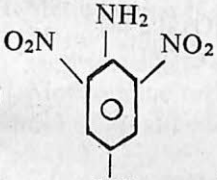

14. In glycine, the basic group is

(a) $-NH_2$ (b) $-\overset{\oplus}{N}H_3$

(c) $-COOH$ (d) $-COO^{\ominus}$

15. On heating salicylic acid with acetic anhydride in the presence of a small quantity of concentrated sulphuric acid there results in the formation of

(a) dye (b) drug
(c) explosive (d) resin

16. In CH_3COOH and HCOOH, HCOOH will be
(a) more acidic (b) less acidic
(c) equally acidic (d) not acidic at all

17. Which acid is used for removing ink spots ?
(a) Oxalic acid (b) Citric acid
(c) Tartaric acid (d) Formic acid

18. The indicator used in titrating oxalic acid with caustic soda solution is
(a) methyl orange (b) methyl red
(c) phenolphthalein (d) fluorescein

19. The hydrolysis of stearin produces stearic acid and
(a) NaOH (b) HCl
(c) glycerol (d) C_3H_7OH

20 Which of the following acids is manufactured from cellulose ?
(a) Citric acid (b) Formic acid
(c) Oxalic acid (d) Tartaric acid

21. Which of the following is present in the stings of bees and wasps ?
(a) Acetic acid (b) Formic acid
(c) Formalin (d) Formaldehyde

22. Malonic acid on heating yields
(a) acetic acid (b) acetone
(c) acetic anhydide (d) formic acid

23. Which of the following gives a green colour with naphthol solution in conc H_2SO_4 ?
(a) Acetic acid (b) Oxalic acid
(c) Citric acid (d) Tartaric acid

24. Lactic acid is
(a) α-hydroxy propionic acid
(b) β-hydroxy propionic acid
(c) propionic acid
(d) none of these

25. Sodium salicylate when distilled with soda lime gives
(a) phenol (b) benzoic acid
(c) salicylic acid (d) sodium benzoate

26. Most of phthalic anhydride is produced from
(a) benzene (b) turpentine
(c) anthracene (d) naphthaline

27. On heating salicylic acid with phenol in the presence of phosphoryl chloride, we get
(a) Oil of wintergreen (b) Salol
(c) Aspirin (d) Gallic acid

28. The product obtained on treatment of salicylic acid with sodium and isopentanol is
    (a) benzoic acid (b) phenol
    (c) pimelic acid (d) none of these
29. On heating, sodium phenoxide with CO_2 under pressure, to about 120—140°C, we get
    (a) benzoic acid (b) phthalic acid
    (c) salicylic acid (d) none of these
30. When phthalic anhydride is condensed with benzene in the presence of anhydrous aluminium chloride, we get
    (a) anthracene (b) anthraquinone
    (c) bakelite (d) none of the above

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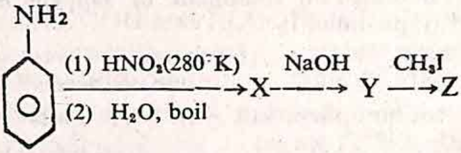
AMINES, AMIDES AND ESTERS

1. Amides may be converted into amines by reaction named after
    (a) Kekule (b) Claisen
    (c) Perkin (d) Hofmann
2. Which is the correct statement ?
    (a) Methylamine is slightly acidic
    (b) Methylamine is less basic than ammonia
    (c) Methylamine is stronger base than ammonia
    (d) Methyamine forms salts with alkalies
3. Gabriel's phthalimide synthesis is used for the preparation of
    (a) primary aromatic amine
    (b) primary aliphatic amine
    (d) secondary amine
    (d) tertiary amine
4. Identify Z in the series

$$C_6H_5NH_2 \xrightarrow{NaNO_2/HCl} X \xrightarrow{CH_2(CN)_2} Y \xrightarrow{H_2O/H^+} Z$$

    (a) $C_6H_5CH_2COOH$
    (b) C_6H_5COOH
    (c) $C_6H_5NHCH_3$
    (d) $C_6H_5CH_2NH_2$

5. Identify 'Z' in



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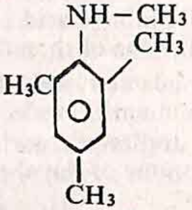

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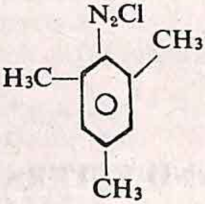

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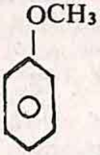

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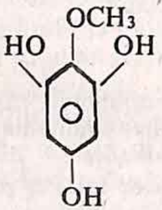


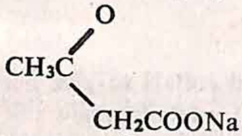
6. A primary amine can be distinguished from secondary and tertiary amines by
   - (a) carbylamine reaction
   - (b) reaction with methyl iodide
   - (c) reaction with acetyl chloride
   - (d) none of the above reactions

7. Nitrobenzene on reduction in acidic medium gives
   - (a) aniline (d) nitroso benzene
   - (c) phenylhydroxylamine
   - (d) azo benzene

8. An example of secondary amines is
   (a) $C_2H_5NH_2$ (b) $(C_2H_5)_2NH$
   (c) $(C_2H_5)_3N$ (d) $(C_2H_5)_4N^+$
9. Ethylamine reacts with nitrous acid to give
   (a) CH_3OH (b) C_2H_5OH
   (c) C_2H_6 (d) $C_2H_5NO_2$
10. Ethyl isocyanate on hydrolysis gives
    (a) ethyl acetate (b) ethyl amine
    (c) ethyl cyanide (d) propionamide
11. Methyl isocyanide on reduction produces
    (a) methylamine (d) ethylamine
    (c) dimethylamine (d) trimethylamine
12. Reaction between caustic soda and a fat is called
    (a) saponification (b) esterification
    (c) fermentation (d) hydrogenation
13. During hydrogenation of oils which of the following catalyst is commonly used ?
    (a) Pd (b) Ni
    (c) Fe (d) V_2O_5
14. Identify Z in the series

$$CH_3CHO \xrightarrow[\text{dil. } H_2SO_4]{MnO_4^-} X \xrightarrow{SOCl_2} Y \xrightarrow[\text{heat}]{CH_3COONa} Z$$

(a)



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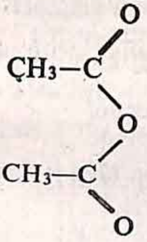

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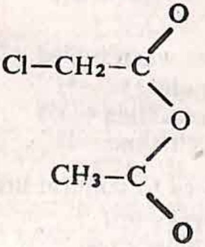
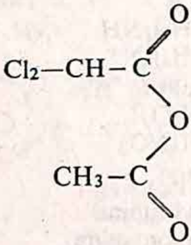


(d) 

15. Oils and fats belong to the class of
    (a) alcohols (b) acids
    (c) esters (d) hydrocarbons

16. Ethylacetate on heating with sodium in the presence of C_2H_5OH gives
    (a) malonic ester (b) acetoacetic ester
    (c) cyanoacetic ester (d) none of these

17. Malonic ester reacts with urea to give
    (a) barbituric acid (b) caffeine
    (c) pyridine (d) none of these

18. When ammonium cyanate is heated we get
    (a) ammonium carbonate
    (b) carbon monoxide
    (c) carbon dioxide
    (d) urea

19. Acetamide reacts with Br_2 and NaOH to give
    (a) acetic acid (b) methylamine
    (c) bromoacetic acid (d) ethane

20. When acetamide is hydrolysed by boiling with acid, the product obtained is
    (a) ethylamine (d) ethyl alcohol
    (c) acetic acid (d) acetaldehyde

21. Which of the following is formed when urea is heated ?
    (a) Ammonium cyanate
    (b) Ammonia (c) Carbon dioxide
    (d) Formic acid

22. Which of the following substances when boiled with caustic soda solution will evolve ammonia ?
    (a) Ethylamine (b) Acetamide
    (c) **Aniline** (d) Acetoxime

23. Which of the following tests is used to confirm urea?
    (a) Biuret test (b) Legal's test
    (c) Lassaigne's test (d) Wholer's test

24. Amides may be converted to amines by
    (a) Perkins reaction
    (b) Hofmann reaction
    (c) Kolbes reaction
    (d) Claisen reaction

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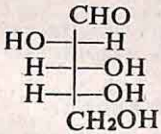
CARBOHYDRATES

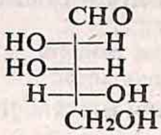
1. Starch is a polymer of
   (a) glucose (b) fractose
   (c) both of the above (d) none of the above
2. On heating glucose with Fehling's solution we get a ppt. whose colour is
   (a). yellow (b) red
   (c) black (d) white
3. Which of the following treatments will convert starch directly into glucose ?
   (a) Heating it with dil H_2SO_4
   (b) Fermentation by diastase
   (c) Fermentation by zymase
   (d) Heating with NaOH
4. Which is the structure of D-xylose ?

(a)



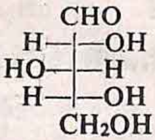
$$\begin{array}{c} \mathrm{CHO} \\ \mathrm{HO}-|-\mathrm{H} \\ \mathrm{H}-|-\mathrm{OH} \\ \mathrm{H}-|-\mathrm{OH} \\ \mathrm{CH_2OH} \end{array}$$

(b)



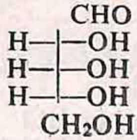
$$\begin{array}{c} \mathrm{CHO} \\ \mathrm{HO}-|-\mathrm{H} \\ \mathrm{HO}-|-\mathrm{H} \\ \mathrm{H}-|-\mathrm{OH} \\ \mathrm{CH_2OH} \end{array}$$

(c)



$$\begin{array}{c} \mathrm{CHO} \\ \mathrm{H}-|-\mathrm{OH} \\ \mathrm{HO}-|-\mathrm{H} \\ \mathrm{H}-|-\mathrm{OH} \\ \mathrm{CH_2OH} \end{array}$$

(d)



$$\begin{array}{c} \mathrm{CHO} \\ \mathrm{H}-|-\mathrm{OH} \\ \mathrm{H}-|-\mathrm{OH} \\ \mathrm{H}-|-\mathrm{OH} \\ \mathrm{CH_2OH} \end{array}$$

5. It is best to carry out reactions with sugars in neutral or acid medium and not in alkaline medium. This is because

in alkaline medium sugars undergo one of the following changes

(a) racemisation (d) decomposition
(c) inversion (d) rearrangement

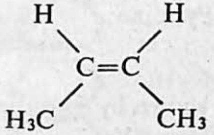
6. Glucose forms many derivatives. The derivative which will help to prove the furanose structure is
   (a) osazone
   (b) benzoyl
   (c) acetyl
   (d) isopropylidene
7. The solution of sugar in water contains
   (a) free atoms
   (b) free ions
   (c) free molecules
   (d) free atoms and free molecules
8. In a given sample of wine glucose can be tested by
   (a) Molisch's test (b) Legal's test
   (c) Dunstan's test (d) Biuret test
9. Which of the following gives a deep blue colour with a drop of dilute solution of iodine?
   (a) Cellulose (b) Glucose
   (c) Starch (d) Sugar
10. The % age of glucose in human blood is
    (a) 0.1 (b) 0.2
    (c) 9.3 (d) 0.4
11. The main source of cellulose is
    (a) cotton
    (b) wood
    (c) both cotton and wood
    (d) none of the above
12. Glucose and fructose are
    (a) geometrical isomers
    (b) metamers
    (c) optical isomers
    (d) none of these
13. How many isomers of glucose are known?
    (a) 4 (b) 8
    (c) 16 (d) 32
14. In the process of mutarotation freshly prepared glucose solution is
    (a) treated in HCl
    (b) treated with NaOH
    (c) boiled with water
    (d) allowed to stand

40

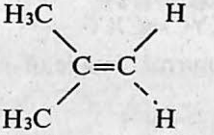
STEREOCHEMISTRY

1. The process of separation of racemic modifications into d- and l-enantiomers is called
   (a) resolution (d) revolution
   (c) dehydration (d) dehydrohalogenation
2. Which of the following is an optically-active compound ?
   (a) n-propanol (d) n-butanol
   (c) 2-chlorobutane (d) 4-hydroxy hexane
3. Geometrical isomerism is possible in case of
   (a) ethane (b) propane
   (c) butene-2 (d) propene
4. Which one of the following shows geometrical isomerism ?

(a)



(a)



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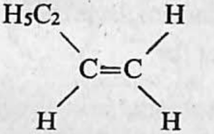

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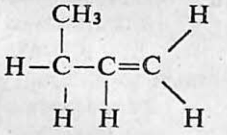

5. Mesotartaric acid is optically inactive due to the presence of
   (a) molecular symmetry
   (b) molecular asymmetry
   (c) external compensation
   (d) two asymmetric carbon atoms

6. Which of the following is an optically active compound ?
   (a) CH_3CH_2COOH (b) $CH_3CH(OH)\ COOH$
   (c) $HOOCCH_2COOH$
   (d) $CH_3COCOOH$

7. In cyclohexane the C—C bond angle is
   (a) 60° (b) 90°
   (c) 109° 28′ (d) 120°

8. The number of stereoisomers in case of a compound having n dissimilar asymmetric carbon atoms is
   (a) $2^{1/n}$ (b) $1/2^n$
   (c) 2^n (d) none of these

9. Maleic anhydride can show
   (a) geometrical isomerism
   (b) optical isomerism
   (c) structural isomerism
   (d) tautomerism

10. Which of the following possesses aromatic characteristics?
   (a) Cyclohexanol (b) Pyridine
   (c) Benzene hexachloride
   (d) Cyclohexane

11. The cis-trans isomerism will be shown by
   (a) $XYC{=}CZ_2$ (b) $X_2C{=}CY_2$
   (c) $X_2C{=}CXY$ (d) $XYC{=}CXY$

12. Optical isomers that are not mirror image of each other are known as
   (a) enantiomers (d) mesomers
   (c) tautomers (d) diastereoisomers

13. The number of possible isomers for $CH_2OH(CHOH)_3CHO$ is
   (a) 2 (b) 4
   (c) 8 (d) 16

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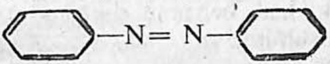
DIAZONIUM SALTS AND NITROCOMPOUNDS

1. Which of the following is a diazonium salt ?
   (a) $C_6H_5N_2Cl$
   (b) $C_6H_5NH_2.HCl$
   (c) C_6H_5ONa
   (d) $C_6H_5COONH_4$
2. Picric acid is
   (a) a volatile liquid
   (b) trinitrotoluene
   (c) trinitroaniline
   (d) 2, 4, 6-trinitrophenol
3. The structure of azobenzene is

(a)



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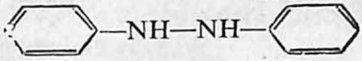

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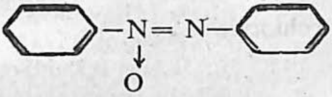

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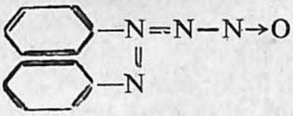

4. Oil of "Mirabane" is
   (a) benzene sulphonic acid
   (b) chlorobenzene
   (c) nitrobenzene
   (d) phenol.
7. The Sandmeyer reaction of diazonium salts is a reaplacement reaction of
   (a) hydrogen (b) hydroxyl group
   (c) halides (d) coupling
6. Benzenediazonium chloride on treatment with boiling water
   (a) dissolves in it
   (b) forms chlorobenzene
   (c) forms phenol
   (d) forms aniline

7. Benzene diazonium chloride is converted into benzene by
   (a) Sandmeyers reaction
   (b) Wurtz-Fittig reaction
   (c) Kolbe reaction
   (d) Etard reaction

8. Which of the following is a coupling reaction ?
   (a) Water+$C_6H_5N_2Cl$
   (b) $C_6H_5OH+C_6H_5N_2Cl$
   (c) $HNO_2+C_6H_5N_2Cl$
   (d) $Na_2SnO_2+C_6H_5N_2Cl$

9. The reaction of aniline with nitrous acid at low temperature gives
   (a) a *n*-nitroso amine
   (b) a diazonium salt
   (c) a nitrile
   (d) an amine nitrite salt

10. The product formed when benzene diazonium chloride is treated with sodium sulphite is
    (a) chlorobenzene
    (b) benzene
    (c) phenol
    (d) phenyl hydrazine chloride

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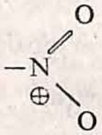
MISCELLANEOUS QUESTIONS

1. Aspirin is
   (a) antibiotic (b) antipyretic
   (c) sedative (d) psychedelic

2. Lemon is sour due to the presence of
   (a) tartaric acid (b) sulphuric acid
   (c) citric acid (d) oxalic acid

3. Ascorbic acid is a/an
   (a) enzyme (b) protein
   (c) vitamin (d) carbohydrate

4. Enzymes are
   (o) minerals (b) oils
   (c) fatty acids (d) proteins
5. A detergent is a
   (a) cleansing agent (b) soap
   (c) catalyst (d) antibiotic
6. Substances used in bringing down the temperature in high fevers are called
   (a) pyretics (b) antibiotics
   (c) antiseptics (d) antipyretics
7. The function of zymase is to
   (i) change starch into sugar
   (ii) ferment glucose to alcohol and carbon dioxide
   (iii) change malt sugar into Glucose
   (iv) change starch into malt sugar and dextrin
   (a) (i), (ii) and (iv) are correct
   (b) (i) and (iv) are correct
   (c) (ii) is correct
   (d) (iv) is correct
8. Structurally, a biodegradable detergent should contain a
   (a) normal-alkyl chain
   (b) branched-alkyl chain
   (c) phenyl side chain
   (d) cyclohexyl side chain
9. Insulin, a hormone, is chemically a
   (a) fat (b) steroid
   (c) protein (d) carbohydrate
10. Which of the following shall decompose on passage of an electric current through its aqueous solution ?
   (a) Urea (b) Glucose
   (c) $AgNO_3$ (d) C_2H_5OH
11. Formation of soap involves
   (a) hydrolysis (b) polymerisation
   (c) esterification (d) condensation
12. Which of the following substances is used as a refrigerant in refrigerator?
   (a) Chloroform
   (b) Carbon disulphide
   (c) Dichlorofluoromethane
   (d) Liquid nitrogen
13 Ascorbic acid is a
   (a) vitamin (b) enzyme
   (c) protein (d) None of these

14. Penicilline was first discovered by
    (a) A. Fleming (b) Tence and Salke
    (c) S.A. Waksna (d) Lewis
15. Vitamin A is also known as
    (a) axerophythol (b) thiamine
    (c) riboflavin (d) pyridoxin
16. Aureomycin is
    (a) anasthetic (d) analgesic
    (c) antiseptic (d) antibiotic
17. Which group is not considered to be a chromophore ?
    (a) $-N=O$ (b) NH_3
    (c)  $-\overset{\oplus}{\mathrm{N}}\begin{smallmatrix}\diagup \mathrm{O}\\ \diagdown \mathrm{O}\end{smallmatrix}$ (d) $-N=N-$
18. A vitamin which is a steroid is
    (a) vitamin A (b) vitamin B
    (c) vitamin C (d) vitamin D
19. Which is pellagra-preventing vitamin?
    (a) Niacin (b) Thymine
    (c) Calciferol (d) Ascorbic acid
20. The proteins contain different amino acid. The number of these is usually
    (a) 26 (b) 15
    (c) 10 (d) 8
21. The number of amino acid residues in oxytocin is generally
    (a) 2 (b) 9
    (c) 20 (d) 70
22. Bee wax contains
    (a) lauryl palmitate
    (b) cetyl palmitate
    (c) myricyl palmitate
    (d) myricyl cerotate
23. Purity of ghee is tested by
    (a) acid value (b) iodine value
    (d) R/M value (d) saponification value

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NAME REACTIONS IN ORGANIC CHEMISTRY

1. *Wurtz reaction.* An etheral solution of an alkyl halide is treated with sodium to get alkane

$$\underset{\text{alkylhalide}}{R\boxed{X+2Na+X}R} \rightarrow \underset{\text{aıkane}}{R-R}+2NaX$$

This method is not suitable for synthesis of alkanes containing odd number of carbon atoms

Following two mechanisms have been proposed for this reaction

(a) Intermediate formation of an organo-metallic compound

(i) $C_2H_5I+2Na \rightarrow C_2H_5Na+NaI$
(ii) $C_2H_5Na+C_2H_5I \rightarrow C_2H_5C_2H_5+NaI$

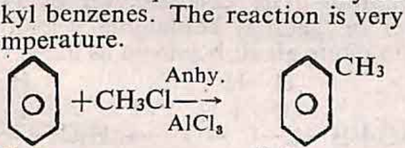
(b) Intermidiate formation of a free radical

$C_2H_5I+Na \rightarrow C_2H_5.+NaI$
$C_2H_5.+C_2H_5. \rightarrow C_2H_5-C_2H_5$

It is a good method for obtaining higher homologues from lower ones

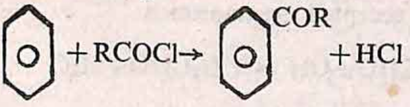
2. *Friedel-Craft's Reaction* This reaction is used for introduction of alkyl, substituted alkyl or acyl groups in the benzene ring. Anhydrous aluminium chloride is used as a catalyst in this reaction

(i) *Friedel-Craft's alkylation.* Benzene reacts with alkyl halides in the presence of anhydrous $AlCl_3$ to form alkyl benzenes. The reaction is very vigorous at room temperature.



Benzene Toluene

(ii) *Friedel-Craft's acylation.* Introduction of acyl group in benzene ring is effected by acid chlorides



It is an electrophilic substitution reaction.

3. *Sabatier and Sanderen's reaction*. The addition of hydrogen to unsaturated hydrocarbons in the presence of Ni as catalyst. The reaction is carried out at 200—300°C.

$$H_2C{=}CH_2 + H_2 \xrightarrow{Ni,250°C} H_3C{-}CH_3$$

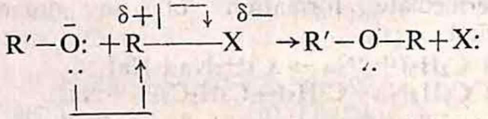
$$HC{\equiv}CH + H_2 \xrightarrow[250°C]{Ni} H_2C{=}CH_2 + H_2 \xrightarrow[Ni]{250°C} H_3C{-}CH_3$$

The reaction is used for conversion of unsaturated hydrocarbons into saturated hydrocarbons

4. *Williamson's synthesis*. It is used to get simple as well as mixed ethers. Alkyl halide is reacted with sodium alkoxide or sodium to get the product

$$R\boxed{X + Na}OR' \rightarrow ROR + NaX.$$

It involves the nucleophilic substitution of strongly basic alkoxide ion for halide ion



$$R'{-}\overset{-}{\underset{\cdot\cdot}{O}}{:} + \overset{\delta+}{R}{-\!\!-\!\!-}\overset{\delta-}{X} \rightarrow R'{-}O{-}R + X{:}$$

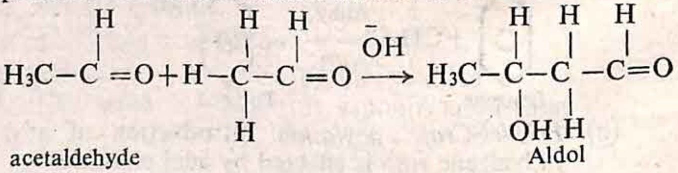
Sodium alkoxides are prepared by the action of sodium on alcohol

$$ROH + Na \rightarrow RONa + \tfrac{1}{2}H_2$$

5. *Rosenmund's reaction* Aldehydes are obtained by the catalytic hydrogentation of acid chlorides. It is carried out by passing hydrogen gas through a hot solution of acid chloride in xylene. Palladium deposited on $BaSO_4$ is used as catalyst.

$$R\,COCl + H_2 \xrightarrow[Heat]{Pd\text{-}BaSO_4} R\,CHO + HCl$$

6. *Aldol Condensation* The condensation of two molecules of aldehydes or ketones containing α-hydrogen, in the presence of a dilute alkali is known as aldol Condensation

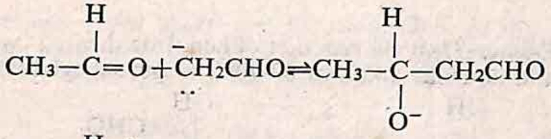


$$H_3C{-}\overset{H}{\overset{|}{C}}{=}O + H{-}\underset{\underset{H}{|}}{\overset{H}{\overset{|}{C}}}{-}\overset{H}{\overset{|}{C}}{=}O \xrightarrow{\bar{O}H} H_3C{-}\underset{\underset{OH}{|}}{\overset{H}{\overset{|}{C}}}{-}\underset{\underset{H}{|}}{\overset{H}{\overset{|}{C}}}{-}\overset{H}{\overset{|}{C}}{=}O$$

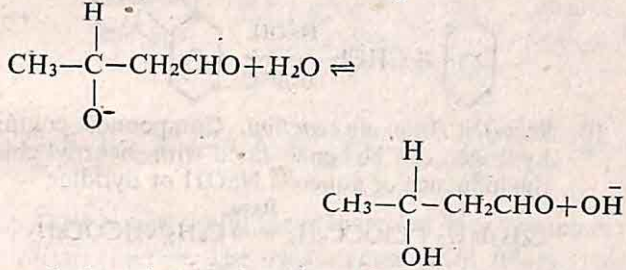
acetaldehyde Aldol

Generally accepted mechanism is

(i) $CH_3CHO + \bar{O}H \rightleftharpoons \bar{C}H_2CHO + H_2O$

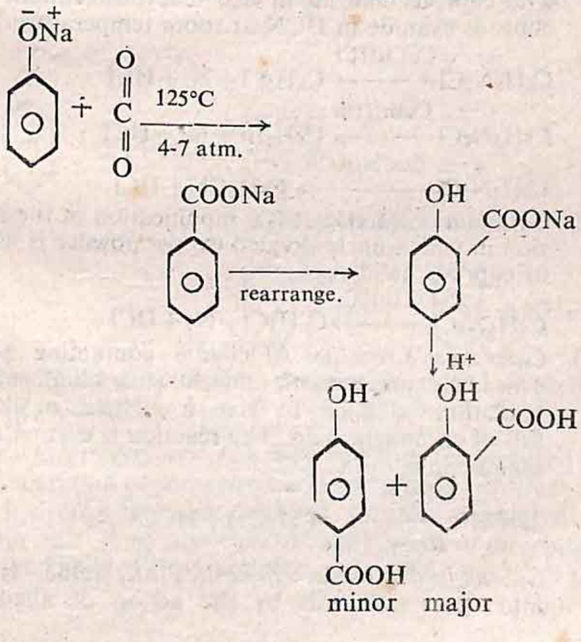
(ii) 

$$CH_3-\overset{H}{\overset{|}{C}}=O+\underset{..}{\overset{-}{C}}H_2CHO \rightleftharpoons CH_3-\underset{O^-}{\overset{H}{C}}-CH_2CHO$$

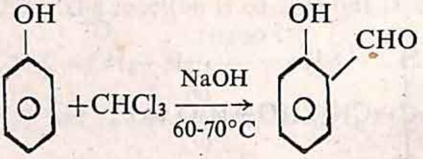
(iii) 

$$CH_3-\underset{O^-}{\overset{H}{C}}-CH_2CHO+H_2O \rightleftharpoons CH_3-\underset{OH}{\overset{H}{C}}-CH_2CHO+\overset{-}{O}H$$

7. *Hofmann's degradation of amides* : *Hofmann's reaction* or *Hofmann Bromamide reaction.*
   When alkaline solution of an amide is treated with bromine, it gives an amine having one carbon atom less than the starting amide.
   $RCONH_2+Br_2+4KOH \rightarrow RNH_2+K_2CO_3+2KBr+H_2O$
8. *Kolbe Schmidt reaction* The reaction was discovered in 1859 by Kolbe and modified by Schmidt in 1885. Sodium phenoxide reacts with CO_2 under pressure (4-7 atmospheres) at 125°C to give sodium salicylate which on hydrolysis with mineral acid produces salicylic acid



9. *Reimer-Tiemann reaction* Phenol is heated with $CHCl_3$ and aqueous alkali at 60-70°C to get salicylaldehyde



10. *Schotten Baumann reaction.* Compounds containing active hydrogen can be benzoylated with benzoyl chloride under the influence of aqueous NaOH or pyridine

$$C_6H_5NH_2 + ClOCC_6H_5 \xrightarrow{\text{Base}} C_6H_5NHCOC_6H_5 + HCl$$

$$C_6H_5O\boxed{H + Cl}OCC_6H_5 \xrightarrow{\text{Base}} C_6H_5OCOC_6H_5 + HCl$$

$$C_6H_5CO\boxed{Cl + H}OC_2H_5 \xrightarrow{\text{Base}} C_6H_5COOC_2H_5 + HCl$$

It seems that the base neutralises HCl and also catalyses the reaction

11. *Sandmeyer reaction* The diazonium group can be replaced by —Cl, —Br or —CN by mixing diazonium salt solution with cuprous chloride in HCl, cuprous bromide in HBr or cuprous cyanide in HCN at room temperature.

$$C_6H_5\overset{+}{N}_2\overset{-}{Cl} \xrightarrow{CuCl/HCl} C_6H_5Cl + N_2 + HCl$$

$$C_6H_5\overset{+}{N}_2\overset{-}{Cl} \xrightarrow{CuBr/HBr} C_6H_5Br + N_2 + HCl$$

$$C_6H_5\overset{+}{N}_2\overset{-}{Cl} \xrightarrow{CuCN/KCN} C_6H_5CN + HCl$$

12. *Gattermann reaction* It is a modification of the above reaction in which finely divided copper powder is used in place of cuprous halide.

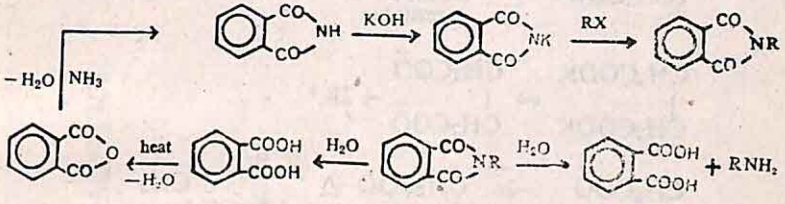
$$C_6H_5\overset{+}{N}_2Cl \xrightarrow{Cu/HCl} C_6H_5Cl + N_2 + HCl$$

13. *Cannizzaro's reaction* Aldehydes containing no α-hydrogen, in the presence of concentrated alkali undergo self oxidation-reduction to give a mixture of alcohol and a salt of carboxylic acid. The reaction is carried out at room temperature.

$$2HCHO \xrightarrow[\text{Room Temp}]{NaOH} CH_3OH + HCO\overset{-}{O}\overset{+}{Na}$$

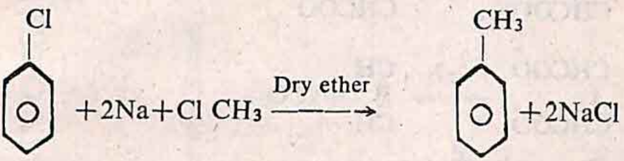
14. *Gabriel phthalimide synthesis* Phthalimide is converted into potassium salt by the action of alcoholic KOH.

Potassium salt when heated with RX gives n-alkyl phthalimide which is hydrolysed to phthalic acid and amine by heating with HCl or KOH solution

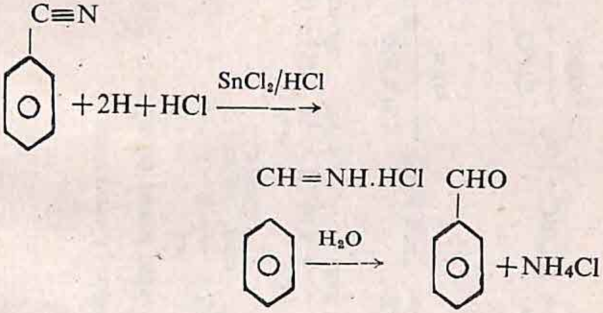


This method is very useful for preparation of pure amines:

15. *Wurtz-Fittigs reaction*. The reaction consists in treating an ethereal solution of an alkyl halide and an aryl halide with sodium. A higher homologue of benzene is obtained.



16. *Stephen's reaction*. Alkyl or aryl cyanides on reduction with $SnCl_2$ and HCl produce an aldimine complex which on warming with water gets hydrolysed to give an aldehyde

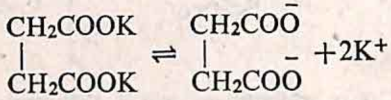


The reaction can be used to prepare aromatic as well as aliphatic aldehydes.

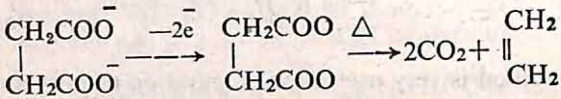
17. *Kolbe's Electrolytic reaction* This reaction is employed for the preparation of saturated and unsaturated hydrocarbons. The hydrocarbons are prepared by the electrolysis of sodium salt of monocarboxylic acids, salts of dicarboxylic acids and salts of unsaturated dicarboxylic acids.

$$2CH_3COONa \rightleftharpoons 2CH_3CO\bar{O}+2\overset{+}{Na}$$

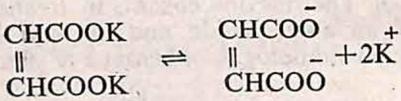
$$2CH_3CO\bar{O} \xrightarrow{-2e} \underset{\text{unstable}}{2CH_3COO} \longrightarrow CH_3-CH_3+2CO_2$$



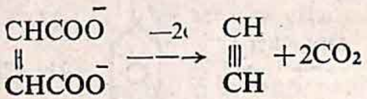
$$\begin{array}{c} CH_2COOK \\ | \\ CH_2COOK \end{array} \rightleftharpoons \begin{array}{c} CH_2CO\bar{O} \\ | \\ CH_2CO\bar{O} \end{array} +2K^+$$



$$\begin{array}{c} CH_2CO\bar{O} \\ | \\ CH_2CO\bar{O} \end{array} \xrightarrow{-2\bar{e}} \begin{array}{c} CH_2COO \\ | \\ CH_2COO \end{array} \xrightarrow{\triangle} 2CO_2+ \begin{array}{c} CH_2 \\ \| \\ CH_2 \end{array}$$



$$\begin{array}{c} CHCOOK \\ \| \\ CHCOOK \end{array} \rightleftharpoons \begin{array}{c} CHCO\bar{O} \\ \| \\ CHCO\bar{O} \end{array} +2\overset{+}{K}$$



$$\begin{array}{c} CHCO\bar{O} \\ \| \\ CHCO\bar{O} \end{array} \xrightarrow{-2e} \begin{array}{c} CH \\ ||| \\ CH \end{array} +2CO_2$$

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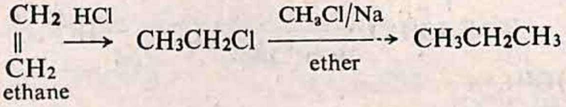
IMPORTANT CONVERSIONS IN ORGANIC CHEMISTRY

Typical Aliphatic Conversions

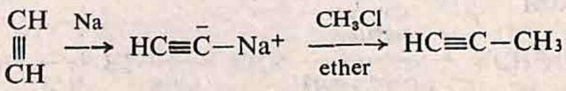
1. Conversion from lower member to higher member of alkanes (by Wurtz reaction)

$$\underset{\text{lower alkane}}{RH} \xrightarrow[\text{light}]{Cl_2} RCl \xrightarrow[\text{ether}]{Na} \underset{\text{higher alkane}}{R-R}$$

(a) $$\underset{\text{methane}}{CH_4} \xrightarrow[\text{light}]{Cl_2} CH_3Cl \xrightarrow[\text{ether}]{Na} \underset{\text{ethane}}{CH_3-CH_3}$$

(b) 

$$\underset{\text{ethane}}{\begin{matrix} CH_2 \\ \| \\ CH_2 \end{matrix}} \xrightarrow{HCl} CH_3CH_2Cl \xrightarrow[\text{ether}]{CH_3Cl/Na} CH_3CH_2CH_3$$

(c) 

$$\begin{matrix} CH \\ ||| \\ CH \end{matrix} \xrightarrow{Na} HC{\equiv}\bar{C}-Na^+ \xrightarrow[\text{ether}]{CH_3Cl} HC{\equiv}C-CH_3$$

(ii) Lower alcohol (ROH) to higher alcohol (RCH_2OH) (through cyanide method)

$$\begin{tikzcd}
ROH \arrow[r, "{P, I_2}"] & RI \arrow[r, "KCN"] & RCN \arrow[r, "Na/C_2H_5OH", "\substack{\text{Mendius}\\ \text{reaction}}"'] & RCH_2NH_2 \arrow[d, "HONO"] \\
& & & RCH_2OH
\end{tikzcd}$$

(a)
$$\begin{tikzcd}
CH_3OH \arrow[r, "P/I_2"] & CH_3I \arrow[r, "Na/C_2H_5OH"] & CH_3CH_2NH_2 \arrow[d, "HONO"] \\
& & CH_3CH_2OH
\end{tikzcd}$$

(b) $CH_3I \xrightarrow{KCN} CH_3CN \xrightarrow{Na/C_2H_5OH} CH_3CH_2NH_2$

$CH_3CH_2NH_2 \xrightarrow{HONO} CH_3CH_2OH \xrightarrow{P, I_2} CH_3CH_2I$

(c) $CH_3NH_2 \xrightarrow{HONO} CH_3OH \xrightarrow{P, I_2} CH_3I$

$CH_3I \xrightarrow{KCN} CH_3CN \xrightarrow{Na/C_2H_5OH} CH_3CH_2NH_2$

(d) $HCHO \xrightarrow{LiAlH_4} CH_3OH \xrightarrow{P, I_2} CH_3I \xrightarrow{KCN} CH_3CN$

$CH_3CN \xrightarrow{Na/C_2H_5OH} CH_3CH_2NH_2 \xrightarrow{HONO} C_2H_5OH \xrightarrow[K_2Cr_2O_7/H_2SO_4]{(O)} CH_3CHO$

(e) $CH_3COOH \xrightarrow{LiAlH_4} CH_3CH_2OH \xrightarrow{P,\ I_2} C_2H_5I \xrightarrow{KCN} C_2H_5CN$

$C_2H_5CN \xrightarrow[\text{hydrolysis}]{HCl} C_2H_5COOH$

(f) $CH_3CONH_2 \xrightarrow{HOH} CH_3COOH \xrightarrow{LiAlH_4} C_2H_5OH \xrightarrow{P,\ I_2} C_2H_5I$

$C_2H_5I \xrightarrow{KCN} C_2H_5CN \xrightarrow[\text{hydrolysis}]{\text{Partial}} CH_3CH_2CONH_2$

Descent of series. It can be brought about by (i) heating sodium salt of a fatty acid with soda lime (ii) By Hofmann Bromamide reaction.

(i) *By heating sodium salt of a fatty acid with soda lime.*

(a) $C_2H_6 \xrightarrow[\text{light}]{Cl_2} C_2H_5Cl \xrightarrow{\text{Aq. KOH}} C_2H_5OH \xrightarrow{(O)} CH_3CHO$

$CH_3CHO \xrightarrow{(O)} CH_3COOH \xrightarrow{NaOH} CH_3COONa \xrightarrow[\text{heat}]{NaOH/CaO} CH_4$

(*ii*) *By Hofmann Bromamide reaction*

(a) $CH_3CH_2I \xrightarrow{\text{Aq. KOH}} CH_3CH_2OH \xrightarrow[K_2Cr_2O_7/H_2SO_4]{(O)} CH_3CHO$

$CH_3CONH_2 \xleftarrow{\text{heat}} CH_3COONH_4 \xleftarrow{NH_3} CH_3COOH \xleftarrow{(O)}$

$\xrightarrow{Br_2/KOH} CH_3NH_2 \xrightarrow{HONO} CH_3OH \xrightarrow{P,\ I_2} CH_3I$

(b)

$$\begin{tikzcd}
C_2H_5OH \arrow[r, "(O)", "K_2Cr_2O_7/H_2SO_4"'] & CH_3CHO \arrow[r, "(O)"] & CH_3COOH \arrow[r, "NH_3"] & CH_3COONH_4 \arrow[dl, "heat"] \\
CH_3OH & CH_3NH_2 \arrow[l, "HONO"'] & CH_3CONH_2 \arrow[l, "Br_2/KOH"'] &
\end{tikzcd}$$

(c)

$$\begin{tikzcd}
C_2H_5NH_2 \arrow[r, "HONO"] & C_2H_5OH \arrow[r, "(O)"] & CH_3CHO \arrow[r, "(O)"] & CH_3COOH \arrow[dl, "NH_3"] \\
CH_3NH_2 & CH_3CONH_2 \arrow[l, "Br_2/KOH"'] & CH_3COONH_4 \arrow[l, "heat"'] &
\end{tikzcd}$$

(d)

$$CH_3CHO \xrightarrow{(O)} CH_3COOH \xrightarrow{NH_3} CH_3COONH_4 \xrightarrow{heat} CH_3CONH_2$$

$$CH_3CONH_2 \xrightarrow{Br_2,\ KOH} CH_3NH_2 \xrightarrow{HONO} CH_3OH \xrightarrow[heat]{Cu} HCHO$$

(e)

$$\begin{tikzcd}
 & & CH_3CH_2COOH \arrow[r, "NH_3"] & CH_3CH_2COONH_4 \arrow[r, "heat"] & CH_3CH_2CONH_2 \arrow[dl, "Br_2/KOH"] \\
CH_3COOH & CH_3CHO \arrow[l, "(O)"'] & CH_3CH_2OH \arrow[l, "(O)"'] & CH_3CH_2NH_2 \arrow[l, "HONO"'] &
\end{tikzcd}$$

(f)

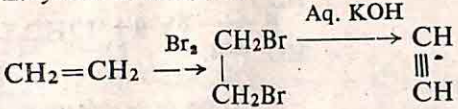
$$\begin{tikzcd}
CH_3CH_2CONH_2 \arrow[r, "Br_2/KOH"] & CH_3CH_2NH_2 \arrow[r, "HONO"] & CH_3CH_2OH \arrow[d, "(O)"] \\
CH_3COONH_4 \arrow[d, "heat"] & CH_3COOH \arrow[l, "NH_3"'] & CH_3CHO \arrow[l, "(O)"'] \\
CH_3CONH_2 & &
\end{tikzcd}$$

Some Typical Aliphatic Conversions

1. *Ethane to ethylene*

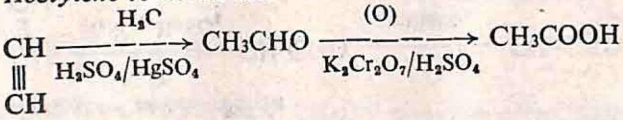
$$CH_3CH_3 \xrightarrow[light]{Cl_2} CH_3CH_2Cl \xrightarrow{Aq\ KOH} CH_2{=}CH_2$$

2. *Ethylene to acetylene*



$$CH_2{=}CH_2 \xrightarrow{Br_2} \begin{array}{c} CH_2Br \\ | \\ CH_2Br \end{array} \xrightarrow{\text{Aq. KOH}} \begin{array}{c} CH \\ ||| \\ CH \end{array}$$

3. *Acetylene to acetic acid*

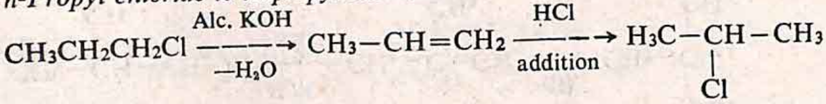


$$\begin{array}{c} CH \\ ||| \\ CH \end{array} \xrightarrow[H_2SO_4/HgSO_4]{H_2C} CH_3CHO \xrightarrow[K_2Cr_2O_7/H_2SO_4]{(O)} CH_3COOH$$

4. *Methyl chloride to acetamide*

$$CH_3Cl \xrightarrow{KCN} CH_3CN \xrightarrow[H_2O/\text{dil } H_2SO_4]{\text{Partial hydrolysis}} CH_3CONH_2$$

5. *n-Propyl chloride to isopropyl chloride*



$$CH_3CH_2CH_2Cl \xrightarrow[-H_2O]{\text{Alc. KOH}} CH_3{-}CH{=}CH_2 \xrightarrow[\text{addition}]{HCl} H_3C{-}\underset{\displaystyle Cl}{\underset{|}{CH}}{-}CH_3$$

6. *Acetaldehyde into lactic acid*

$$CH_3\,CHO \xrightarrow{HCN} CH_3CH(OH)CN \xrightarrow{\text{Hydrolysis}} CH_3CH(OH)COOH$$

7. *Acetaldehyde into methane*

$$CH_3CHO \xrightarrow{\text{ox.}} CH_3COOH \xrightarrow{NaOH} CH_3COONa \xrightarrow[\text{heat}]{\text{Soda lime}} CH_4$$

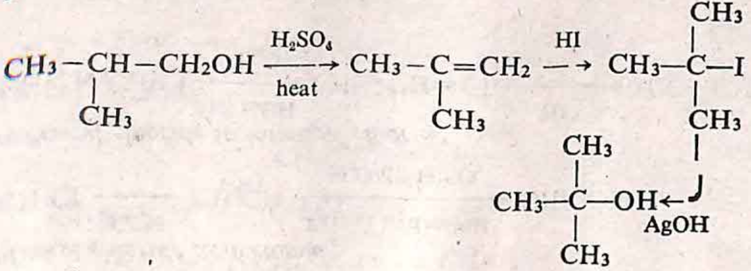
8. *Acetic acid into acetone*

$$CH_3COOH \xrightarrow{CaO} (CH_3COO)_2Ca \xrightarrow{\Delta} CH_3COCH_3$$

9. *Ethyl alcohol into isopropyl alcohol*

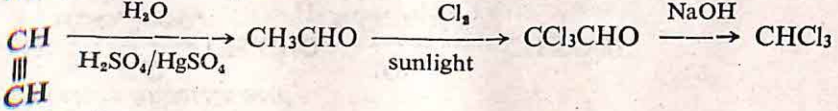
$$CH_3-CH_2-OH \xrightarrow{(O)} CH_3CHO \xrightarrow[\text{Hydrolysis}]{CH_3MgI} CH_3CH(OH)CH_3$$

10. *Primary alcohol to tertiary alcohol*



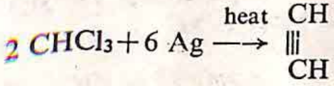
$$\underset{\displaystyle CH_3}{CH_3-\underset{|}{CH}-CH_2OH} \xrightarrow[\text{heat}]{H_2SO_4} \underset{\displaystyle CH_3}{CH_3-\underset{|}{C}=CH_2} \xrightarrow{HI} CH_3-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-I \xrightarrow{AgOH} CH_3-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-OH$$

11. *Acetylene to chloroform*



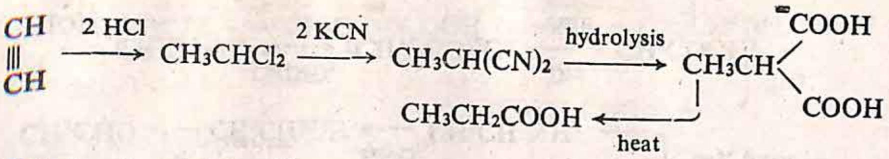
$$\begin{array}{c}CH\\|||\\CH\end{array} \xrightarrow[H_2SO_4/HgSO_4]{H_2O} CH_3CHO \xrightarrow[\text{sunlight}]{Cl_2} CCl_3CHO \xrightarrow{NaOH} CHCl_3$$

12. *Chloroform to acetylene*



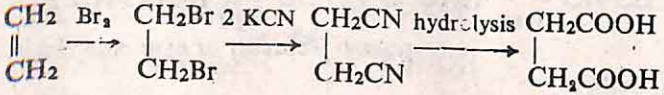
$$2\,CHCl_3+6\,Ag \xrightarrow{\text{heat}} \begin{array}{c}CH\\|||\\CH\end{array}$$

13. *Acetylene to propionic acid*



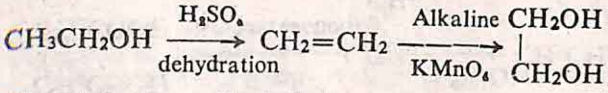
$$\begin{array}{c}CH\\ |||\\ CH\end{array} \xrightarrow{2\,HCl} CH_3CHCl_2 \xrightarrow{2\,KCN} CH_3CH(CN)_2 \xrightarrow{hydrolysis} CH_3CH\begin{array}{l}COOH\\ COOH\end{array} \xrightarrow[heat]{} CH_3CH_2COOH$$

14. *Ethylene to succinic acid*



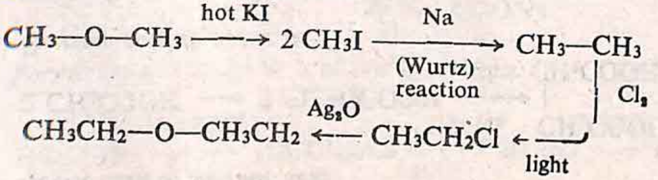
$$\begin{array}{c}CH_2\\ \|\\ CH_2\end{array} \xrightarrow{Br_2} \begin{array}{c}CH_2Br\\ |\\ CH_2Br\end{array} \xrightarrow{2\,KCN} \begin{array}{c}CH_2CN\\ |\\ CH_2CN\end{array} \xrightarrow{hydrolysis} \begin{array}{c}CH_2COOH\\ |\\ CH_2COOH\end{array}$$

15. *Monohydric alcohol to dihydric alcohol*



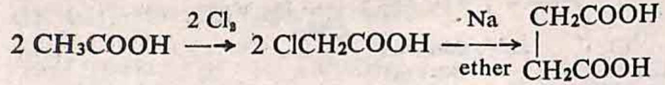
$$CH_3CH_2OH \xrightarrow[dehydration]{H_2SO_4} CH_2{=}CH_2 \xrightarrow[KMnO_4]{Alkaline} \begin{array}{c}CH_2OH\\ |\\ CH_2OH\end{array}$$

16. *Dimethylether to Diethyl ether*



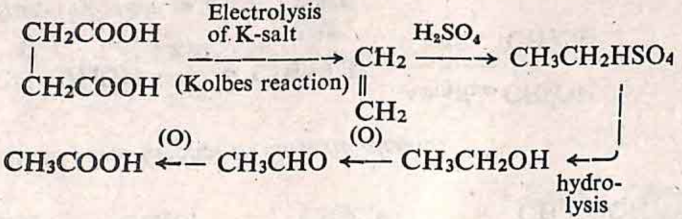
$$CH_3{-}O{-}CH_3 \xrightarrow{hot\ KI} 2\,CH_3I \xrightarrow[\substack{(Wurtz)\\ reaction}]{Na} CH_3{-}CH_3 \xrightarrow[light]{Cl_2} CH_3CH_2Cl \xrightarrow{Ag_2O} CH_3CH_2{-}O{-}CH_3CH_2$$

17. *Acetic acid to succinic acid*



$$2\,CH_3COOH \xrightarrow{2\,Cl_2} 2\,ClCH_2COOH \xrightarrow[\text{ether}]{Na} \begin{array}{c}CH_2COOH\\ |\\ CH_2COOH\end{array}$$

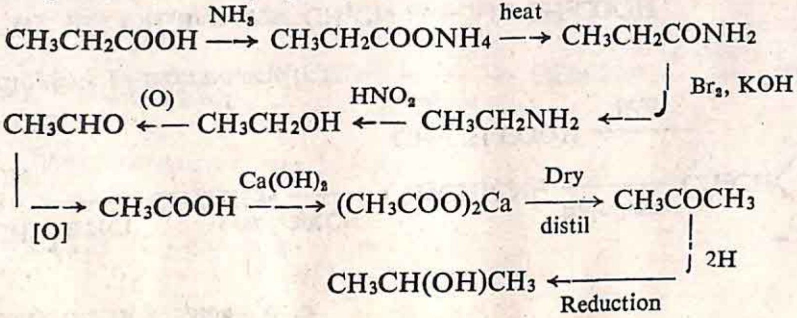
18. *Succinic acid to acetic acid*



$$\begin{array}{c}CH_2COOH\\ |\\ CH_2COOH\end{array} \xrightarrow[\text{(Kolbes reaction)}]{\text{Electrolysis of K-salt}} \begin{array}{c}CH_2\\ \|\\ CH_2\end{array} \xrightarrow{H_2SO_4} CH_3CH_2HSO_4$$

$$CH_3COOH \xleftarrow{(O)} CH_3CHO \xleftarrow{(O)} CH_3CH_2OH \xleftarrow{\text{hydrolysis}} CH_3CH_2HSO_4$$

19. *Propionic acid to isopropyl acohol*



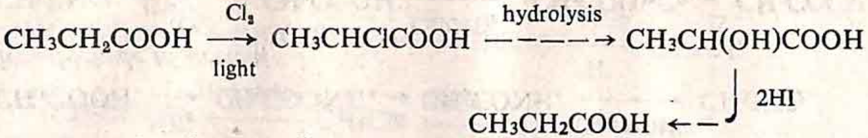
$$CH_3CH_2COOH \xrightarrow{NH_3} CH_3CH_2COONH_4 \xrightarrow{\text{heat}} CH_3CH_2CONH_2$$

$$CH_3CHO \xleftarrow{(O)} CH_3CH_2OH \xleftarrow{HNO_2} CH_3CH_2NH_2 \xleftarrow{Br_2,\ KOH} CH_3CH_2CONH_2$$

$$CH_3CHO \xrightarrow{[O]} CH_3COOH \xrightarrow{Ca(OH)_2} (CH_3COO)_2Ca \xrightarrow[\text{distil}]{\text{Dry}} CH_3COCH_3$$

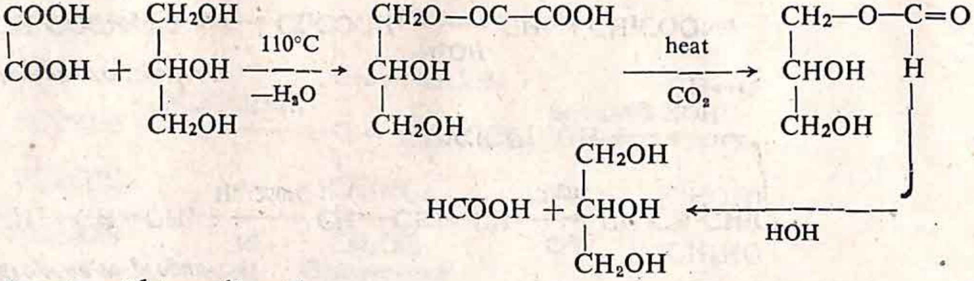
$$CH_3CH(OH)CH_3 \xleftarrow[\text{Reduction}]{2H} CH_3COCH_3$$

20 *Propionic acid to lactic acid and vice versa*



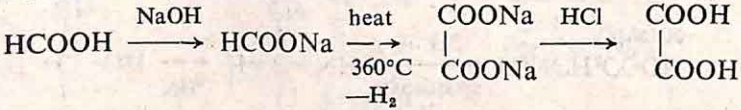
$$CH_3CH_2COOH \xrightarrow[\text{light}]{Cl_2} CH_3CHClCOOH \xrightarrow{\text{hydrolysis}} CH_3CH(OH)COOH \xrightarrow{2HI} CH_3CH_2COOH$$

21. *Oxalic acid to formic acid*



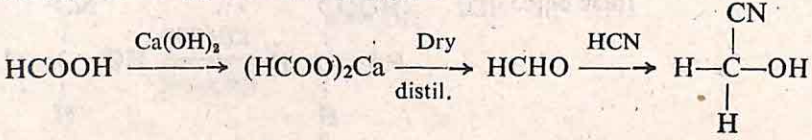
$$\begin{matrix}COOH\\|\\COOH\end{matrix} + \begin{matrix}CH_2OH\\|\\CHOH\\|\\CH_2OH\end{matrix} \xrightarrow[-H_2O]{110°C} \begin{matrix}CH_2O-OC-COOH\\|\\CHOH\\|\\CH_2OH\end{matrix} \xrightarrow[CO_2]{\text{heat}} \begin{matrix}CH_2-O-C=O\\|\qquad\quad|\\CHOH\quad\ H\\|\\CH_2OH\end{matrix} \xrightarrow{HOH} HCOOH + \begin{matrix}CH_2OH\\|\\CHOH\\|\\CH_2OH\end{matrix}$$

22. *Formic acid to oxalic acid*

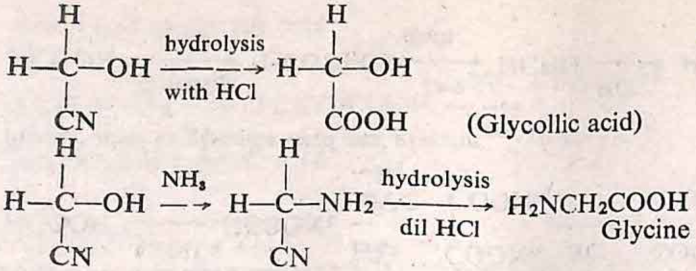


$$HCOOH \xrightarrow{NaOH} HCOONa \xrightarrow[\substack{360°C\\-H_2}]{\text{heat}} \begin{matrix}COONa\\|\\COONa\end{matrix} \xrightarrow{HCl} \begin{matrix}COOH\\|\\COOH\end{matrix}$$

23. *Formic acid to glycollic acid and glycine*



$$HCOOH \xrightarrow{Ca(OH)_2} (HCOO)_2Ca \xrightarrow[\text{distil.}]{\text{Dry}} HCHO \xrightarrow{HCN} H-\overset{\displaystyle CN}{\underset{\displaystyle H}{C}}-OH$$



$$\mathrm{H{-}\overset{\displaystyle H}{\underset{\displaystyle CN}{C}}{-}OH \xrightarrow[\text{with HCl}]{\text{hydrolysis}} H{-}\overset{\displaystyle H}{\underset{\displaystyle COOH}{C}}{-}OH} \quad \text{(Glycollic acid)}$$

$$\mathrm{H{-}\overset{\displaystyle H}{\underset{\displaystyle CN}{C}}{-}OH \xrightarrow{NH_3} H{-}\overset{\displaystyle H}{\underset{\displaystyle CN}{C}}{-}NH_2 \xrightarrow[\text{dil HCl}]{\text{hydrolysis}} \underset{\text{Glycine}}{H_2NCH_2COOH}}$$

24. *Propene to propan-1-ol*

$$\mathrm{CH_3{-}CH{=}CH_2 \xrightarrow[H_2,\ 250^\circ C]{Ni} CH_3{-}CH_2{-}CH_3 \xrightarrow[\text{light}]{Cl_2} CH_3CH_2CH_2Cl}$$

$$\mathrm{CH_3CH_2CH_2OH \xleftarrow[\text{aq. KOH}]{}}$$

25. *Acetone to iodoform*

$$\mathrm{CH_3COCH_3 + 3\,I_2 \longrightarrow CI_3COCH_3 \xrightarrow{NaOH} CHI_3 + CH_3COONa}$$

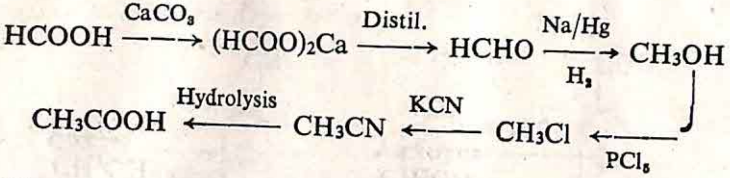
26. *Acetic acid to methylamine*

$$\mathrm{CH_3COOH \xrightarrow{NH_3} CH_3COONH_4 \xrightarrow{\triangle} CH_3CONH_2 \xrightarrow{Br_2/KOH} CH_3NH_2}$$

27. *Acetaldehyde to acetone*

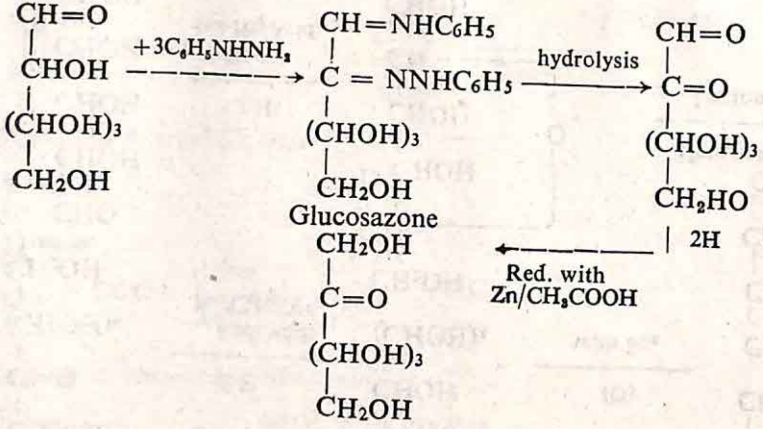
$$\mathrm{CH_3CHO \xrightarrow[Cr_2O_7^{2-}/H^+]{(O)} CH_3COOH \xrightarrow{Ca(OH)_2} (CH_3COO)_2Ca \xrightarrow{\triangle} CH_3COCH_3.}$$

28. *Formic acid to acetic acid*

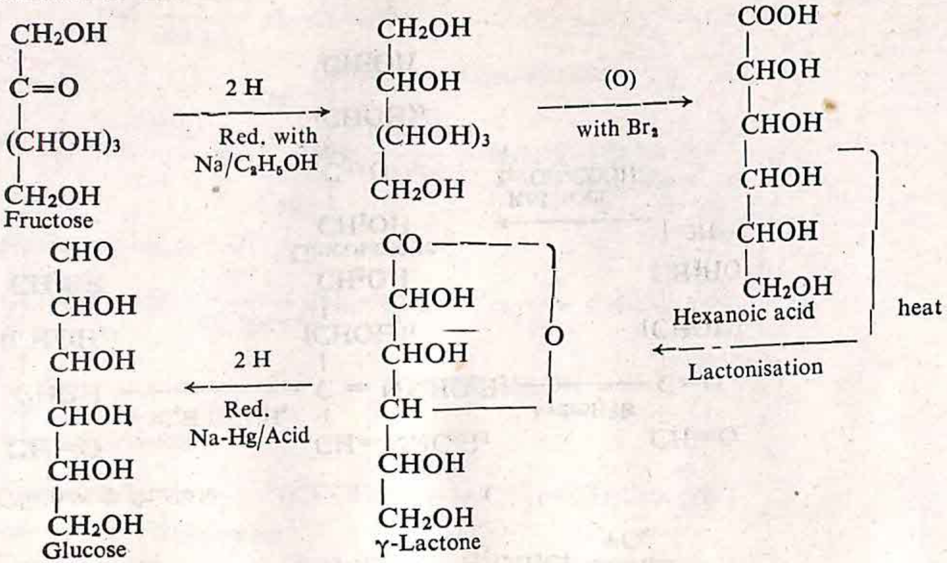


$$HCOOH \xrightarrow{CaCO_3} (HCOO)_2Ca \xrightarrow{\text{Distil.}} HCHO \xrightarrow[H_2]{Na/Hg} CH_3OH \xrightarrow{PCl_5} CH_3Cl \xrightarrow{KCN} CH_3CN \xrightarrow{\text{Hydrolysis}} CH_3COOH$$

29. *Glucose to fructose*

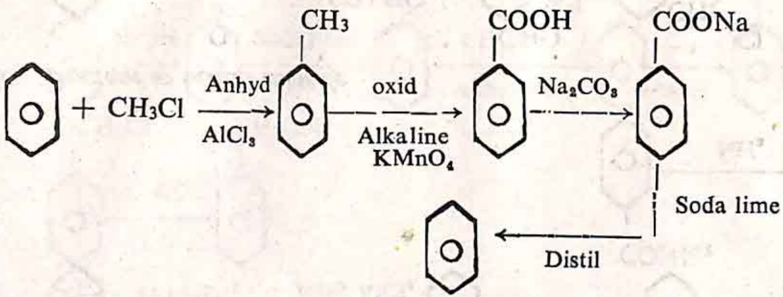


30. *Fructose to Glucose*

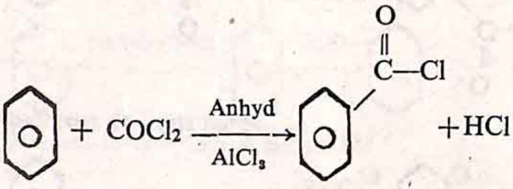


Some typical aromatic conversions

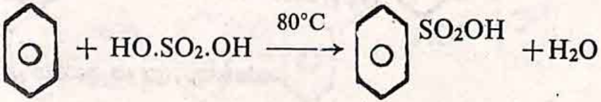
1. *Benzene to toluene and vice versa*



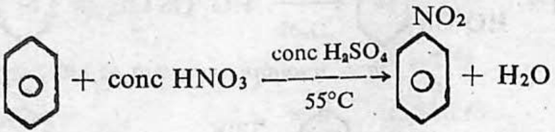
2. *Benzene to benzoyl Chloride*



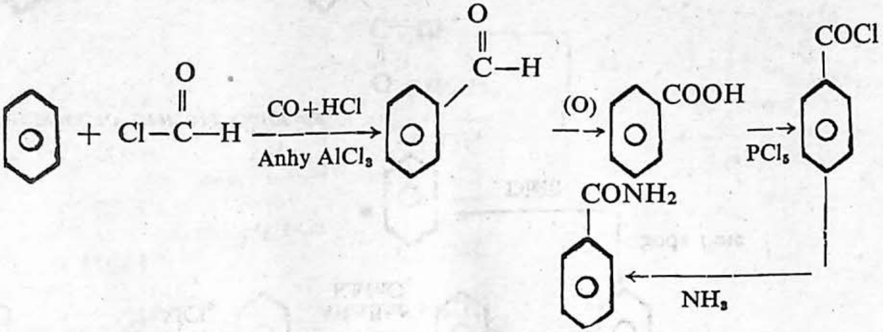
3. *Benzene to benzene sulphonic acid*



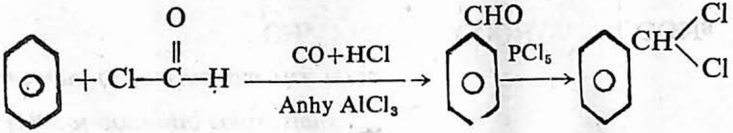
4. *Benzene to nitrobenzene*



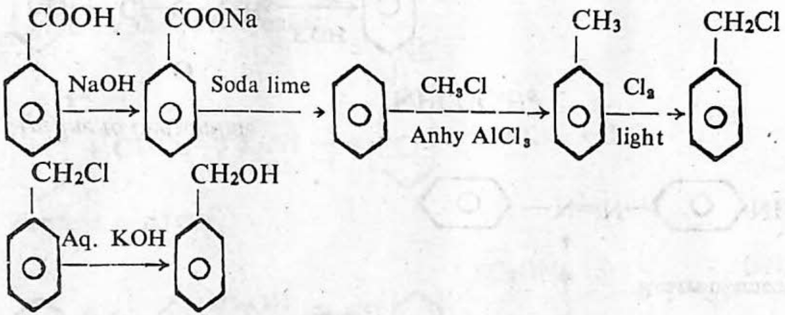
5. *Benzene to benzamide*



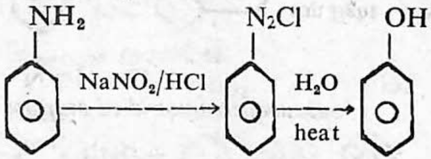
6. *Benzene to benzal chloride*



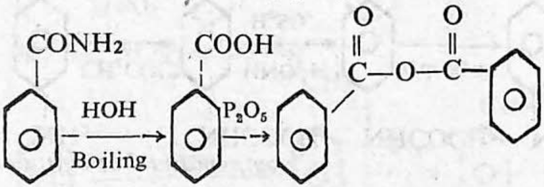
7. *Benzoic acid to Benzyl alcohol*



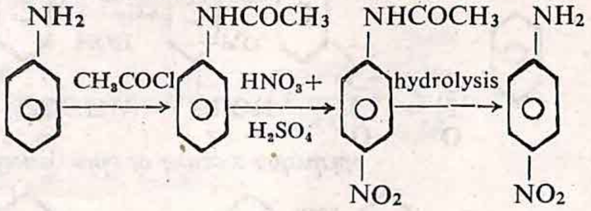
8. *Aniline to phenol*



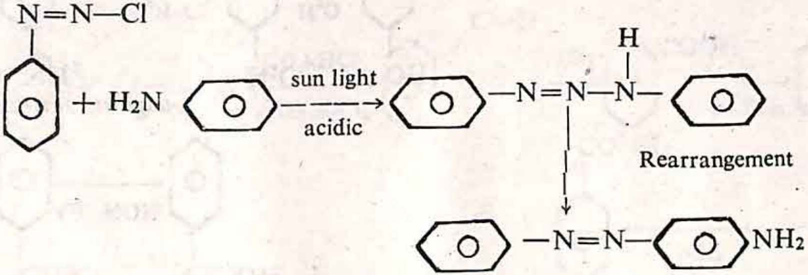
9. *Benzamide to benzoic anhydride*



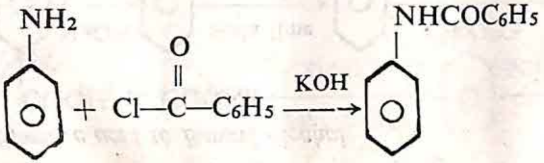
10. *Aniline to p-nitroaniline*



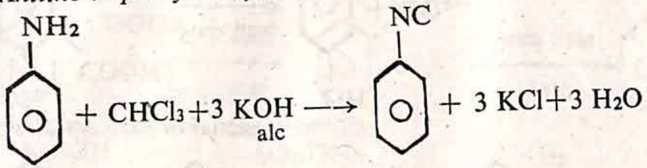
11. *Aniline to p-aminoazobenzene*



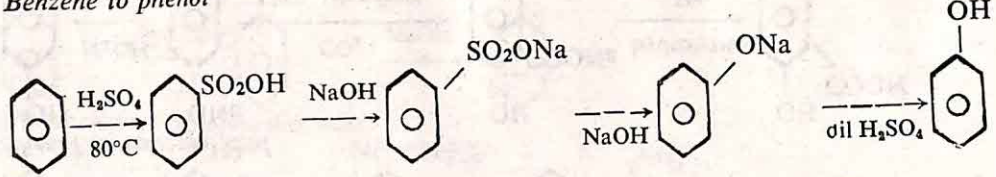
12. *Aniline to benzanilide*



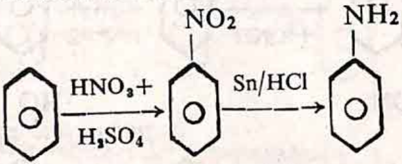
13. *Aniline to phenyl isocyanide*



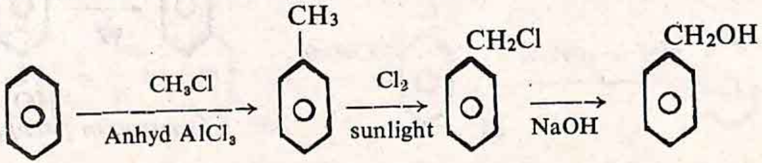
14. *Benzene to phenol*



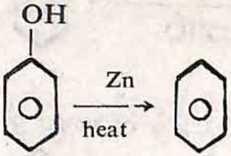
15. *Benzene to aniline*



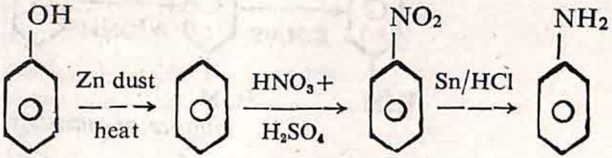
16. *Benzene to benzyl alcohol*



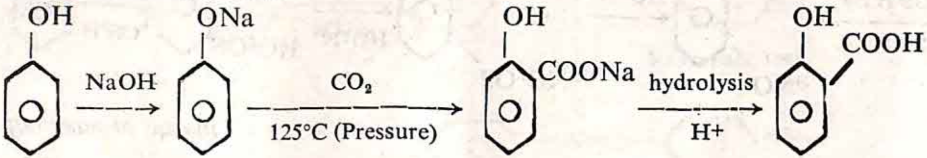
17. *Phenol to benzene*



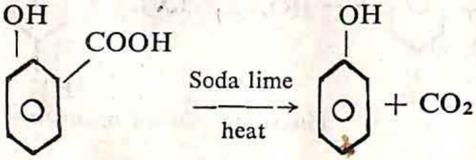
18. *Phenol to aniline*



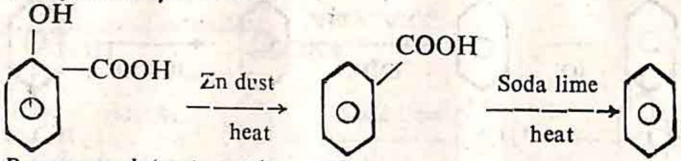
19. *Phenol to salicylic acid*



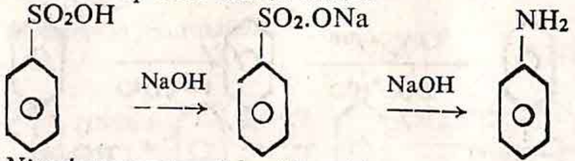
20. *Salicylic acid to phenol*



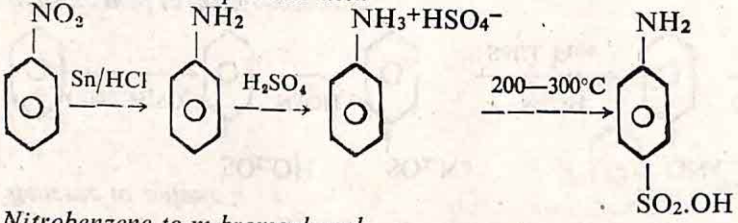
21. *Salicylic acid to benzene*



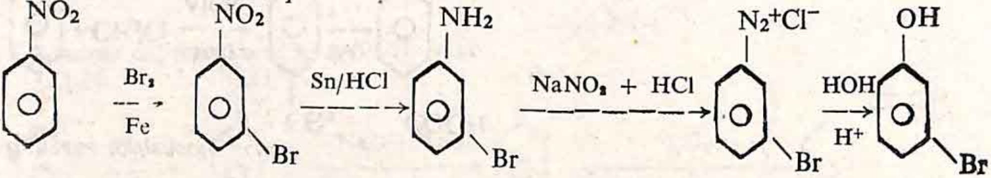
22. *Benzene sulphonic acid to aniline*



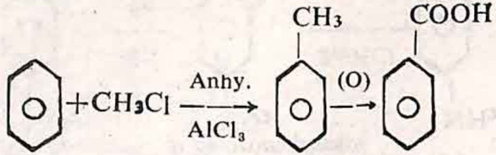
23. *Nitrobenzene to sulphanilic acid*



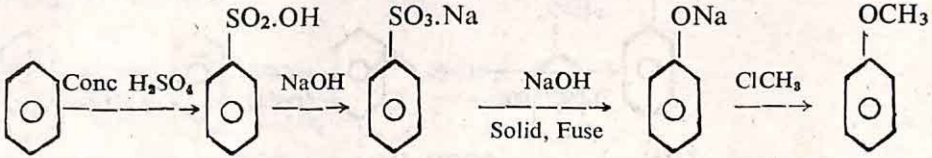
24. *Nitrobenzene to m-bromophenol*



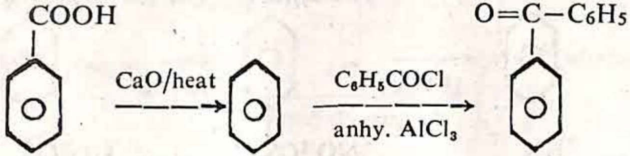
25. *Benzene to benzoic acid*



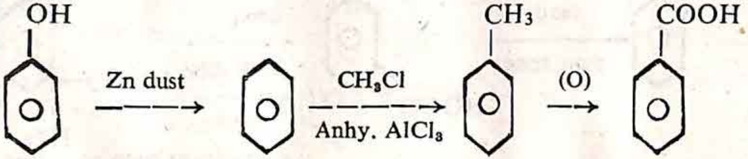
26. *Benzene to anisole*



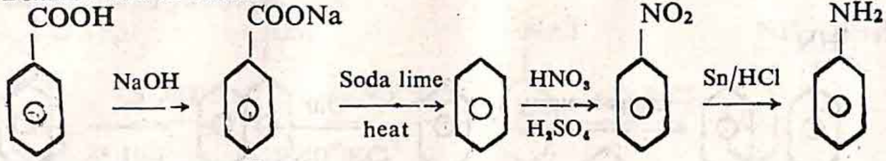
27. *Benzoic acid to benzophenone*



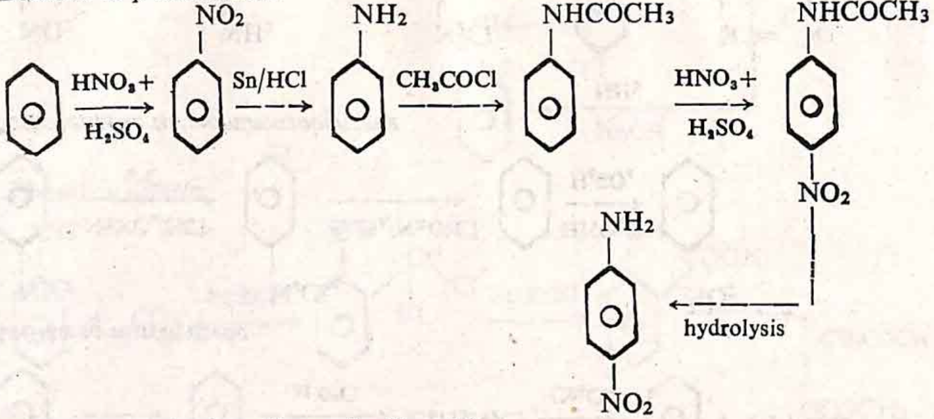
28. *Phenol to benzoic acid*



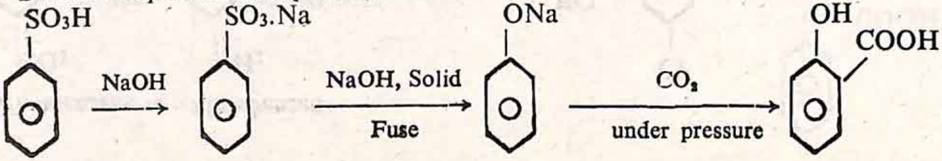
29. *Benzoic acid to aniline*



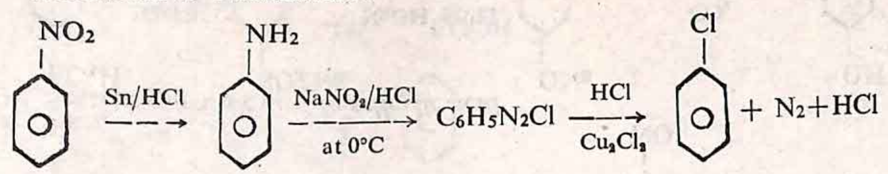
30. *Benzene to p-nitroaniline*



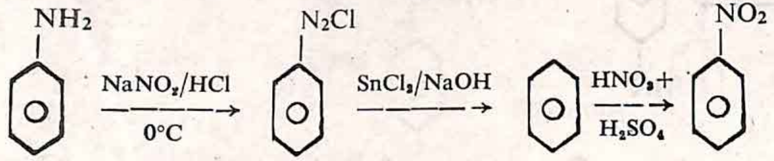
31. *Benzene sulphonic acid to salicylic acid*



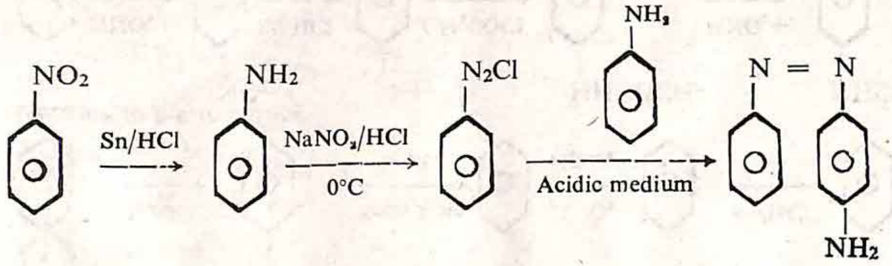
32. *Nitrobenzene to chlorobenzene*



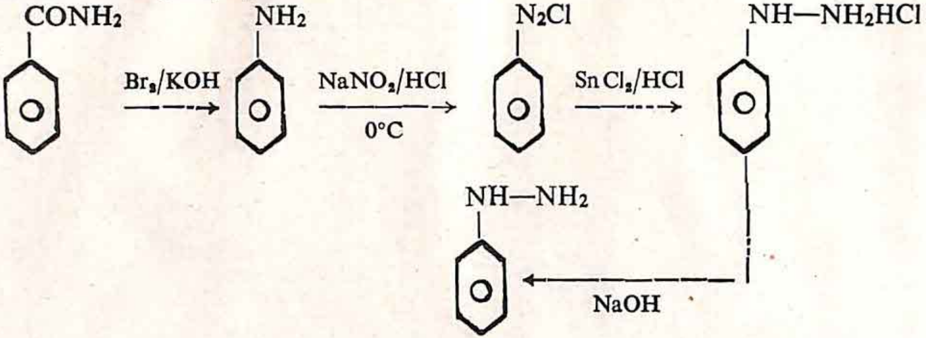
33. *Aniline to nitrobenzene*



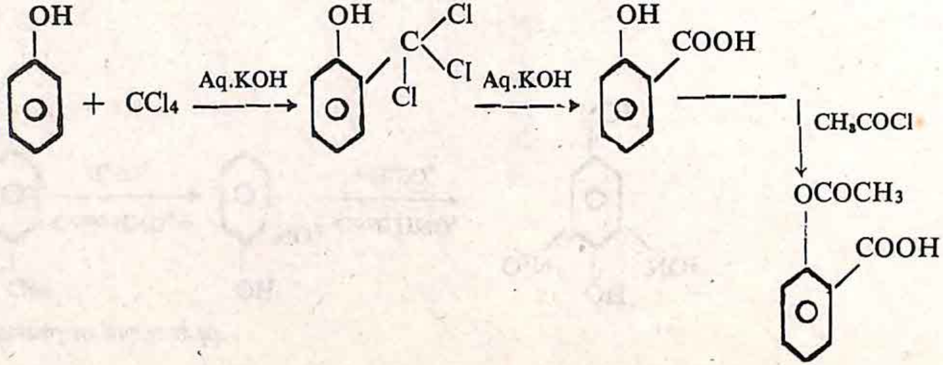
34. *Nitrobenzene to p-aminoazobenzene*



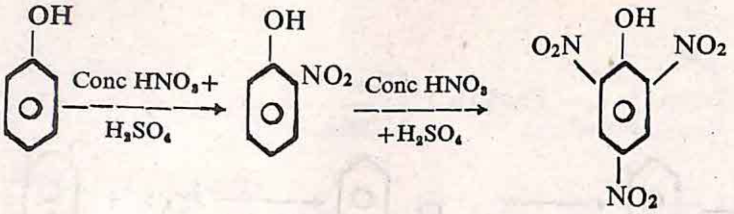
35. *Benzamide to phenylhydrazine*



36. *Phenol to aspirin*



37. *Phenol to picric acid*



PART IV

Miscellaneous Questions

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QUESTIONS BASED ON PROBLEMS

1. An organic compound is found to contain $C=40\%$, $O=53.34\%$, $H=6.66\%$. Its empirical formula is
(a) CH_2O (b) CHO
(c) C_2H_2O (d) CH_4O_2

2. The no. of possible alcohol isomers for $C_4H_{10}O$ are
(a) 2 (b) 3
(c) 4 (d) 5

3. The empirical formula of a compound is CH_2. One mole of this compound has a mass of 42 gms. Its molecular formula is
(a) CH_2 (b) C_2H_2
(c) C_3H_8 (d) C_3H_6

4. A compound with empirical formula C_2H_5O has a vapour density of 45. The molecular formula of the compound will be
(a) C_2H_5O (b) $C_2H_2O_4$
(c) $C_5H_{14}O$ (d) $C_4H_{10}O_2$

5. A compound containing two dissimilar asymmetric atoms can exist in how many optically active forms ?
(a) 2 (b) 3
(c) 4 (d) 8

6. If an average adult burns 3×10^3 k cal of food per day, what weight of fat would be necessary to supply daily caloric requirements ?
(Mol. wt. of fat=256, heat of combustion=−2380,000 cal/mole)
(a) $\frac{1}{3}$ gm (b) 9 gm
(c) $\frac{1}{8}$k gm (d) 3 k gm

7. A sample of an ideal gas is allowed to escape reversibly and isothermally into vacuum. Which statement is correct ?
(a) $w=0, \triangle E=q=$ a positive number
(b) $w=P\triangle V+V\triangle P$
(c) $\Delta E=0$, $q=-w=$ a positive number
(c) $w=0$, $q=0$, $\Delta E=0$

8. Calculate the heat of formation of gaseous ethylene ΔH_f° $[C_2H_4(g)]$

Data	ΔH_f° (k cal mole^{-1})
$CO_2(g)$	-94.1
$H_2O(l)$	-68.3

Heat of combustion of $C_2H_4(g) = -337.3$ k cal mole^{-1}

(a) -175 k cal mole^{-1}
(b) -12.5 k cal mole^{-1}
(c) $+12.5$ k cal mole^{-1}
(d) $+175$ k cal mole^{-1}

9. The amount of heat absorbed when CO_2 gas reacts with solid CaO to form solid $CaCO_3$ is measured in a bomb calorimeter (at constant volume). It gives a direct measure of

(a) ΔE (b) ΔH
(c) $V\Delta P$ (d) ΔG

10. What is the free energy change ΔG when 1.0 mole of water is converted at 100°C and 1 atmosphere pressure to steam at 100°C and 1 atmosphere pressure in a reversible manner

$$[\Delta H_v(H_2O) = 9.7 \text{ k cal mole}^{-1}]$$

(a) -26 cal
(b) -970 cal
(c) 0 cal
(d) 970 cal

11. The equilibrium corcentrations in a 1 litre vessel are as under :

$$PCl_3(g) + Cl_2(g) = PCl_5(g)$$

equi 0.20 0.10 0.40 mole litre ^{1}

Then 0.10 mole of $Cl_2(g)$ was added. What is the new equilibrium concentration of $PCl_5(g)$?

(a) 0.05 mole litre^{-1}
(b) 0·35 mole litre^{-1}
(c) 0.40 mole litre^{-1}
(d) 0.45 mole litre^{-1}

12. K_{sp} for $Pb(IO_3)_2$ is 3.2×10^{-14} at a given temperature. What is the solubility of $Pb(IO_3)_2$ in mole litre^{-1} ?

(a) 3.6×10^{-7}
(b) 2×10^{-5}
(c) 4×10^{-5}
(d) 8×10^{-5}

13. $Ag_2 (C_2O_4)$ is dissolved in pure water. The concentration of Ag^+ in saturated solution is 2.2×10^{-4} mole litre^{-1}. What is the K_{sp} of $Ag_2 (C_2O_4)$?
(a) 5.3×10^{-12}
(b) 11×10^{-12}
(c) 5×10^{-8}
(d) 2.2×10^{-4}

14. The average concentration of K^+ in blood serum is 0.195 g/litre. What is the molarity ?
(a) 0.0050
(b) 0.050
(c) 0.50
(d) 19.5

15. What volume of H_2 measured at STP is liberated when 6.5g of zinc dissolves in excess of dil. HCl ?
(a) 0.0224 litre
(b) 0.112 litre
(c) 0.336 litre
(d) 2.24 litre

16. A compound of xenon and fluorine is found on analysis to contain 53.4% xenon. What is the oxidation number of xenon in the compound ?
[at. wt; F=19, Xe=131]
(a) 0 (b) +2
(c) +4 (d) +6

17. What is the de Broglie wave length of a 1.0 g snail travelling at 5.0 cm/hr ?
[$h=6.6 \times 10^{-27}$ erg sec]
(a) 1.3×10^{-27} A°
(b) 7.9×10^{-26} A°
(c) 4.8×10^{-24} A°
(d) 4.8×10^{-16} A°

18. Carbon suboxide (C_3O_2), a foul smelling gas is prepared by dehydrating malonic acid. How many σ and π bonds are in the structure of this compound ?
(a) Three σ and two π
(b) Four σ and four π
(c) Four σ and no π
(d) Five σ and four π

19. In the tri-iodide (I_3^-), which is linear, the hybridization of the central I is
[I : [Kr] $5s^2$ $4d^{10}$ $5p^5$]
(a) sp (b) sp^2
(c) sp^3 (d) sp^3d

20. An unusual complex of molybdenum is $[Mo(CN)_8]^{4-}$. What is the coordination number of Mo in this complex?
(a) 1 (b) 2
(c) 8 (d) 12

21. What is the oxidation state of Ni in $K_2[Ni(C_2O_4)_2]$?
(a) 2 (b) 3
(c) 4 (d) 6

22. How many unpaired electrons are there in $V(CO)_6$?
[CO is a strong ligand]
(a) 1 (b) 2
(c) 3 (d) 5

23. In 1940, the first isotope of a transuramium element was discovered. The element was named neptunium. The isotope discovered was $^{239}_{93}Np$. How many nucleons are there in the isotope ?
(a) 93 (b) 146
(c) 239 (d) 332

24. In how many kilograms of H_2O should 293 g of NaCl be dissolved to obtain 0.25 molal solution ?
(a) 0.25 (b) 0.50
(c) 5.0 (d) 20.0

25. An excess of NaOH is treated with 1.12 litres of dry hydroyen chloride at STP. What weight of NaCl is formed ?
(a) 0.050 g (b) 1.8 g
(c) 2.0 g (d) 2.9 g

26. The molecular weight of a gas, 0.30 g of which occupies a volume of 82 cm^3 at 3.0 atmosphere pressure at 27°C is
(R=0.082 litre atm per mole per degree)
(a) 3×10^{-2}
(b) 2.7
(c) 30
(d) $\frac{1}{30}$

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QUALITATIVE AND QUANTITATIVE ANALYSIS

1. 10 g of each of the following are taken. Which has the largest number of molecules ?
   (a) C_4H_{10} (b) C_9H_7OH
   (c) C_2H_5Cl (d) CH_3COCH_3
2. The Lucas test is used to determine the type of
   (a) alcohol (b) amine
   (c) acid (d) phenol
3. A mixture of benzene and benzoic acid can be separated by the use of
   (a) toluene (b) HCl
   (c) $NaHCO_3$ (d) C_2H_5OH
4. Both acetaldehyde and acetone react easily with
   (a) Fehling's reagent
   (b) Grignard's reagent
   (c) Schiff's reagent
   (d) Tollen's reagent
5. In Lassaigne's test for nitrogen the green or blue colour obtained is of
   (a) $Fe\,(OH)_2$ (b) $Fe_4\,[Fe(CN)_6]_3$
   (c) $Na_4\,[Fe(CN)_6]$ (d) NaCN
6. Beilstein's test is used for
   (a) sulphur (b) nitrogen
   (c) phosphorous (d) halogens
7. Kjeldahl's method is used for the estimation of
   (a) halogens (b) nitrogen
   (c) oxygen (d) sulphur
8. Which one is not used for detection of unsaturation in organic compounds ?
   (a) Alkaline $KMnO_4$ (b) Br_2 water
   (c) H_2O_2 (d) O_3
9. Hinsberg's test is used to determine the type of
   (a) alcohol (b) amino acid
   (c) amine (d) sugar
10. A substance gives a pink colour with a few drops of ceric ammonium nitrate. The organic substance is

(a) alcohol (b) aldehyde
(c) ketone (d) none of these

11. Separation of two substances by fractional distillation is based on the difference in
(a) densities (b) crystalline shape
(c) solubility (d) volatility

12. The compound that reacts fastest with Lucas reagent at room temperature is
(a) butanol-1
(b) butanol-2
(c) 2-methyl propanol-1
(d) 2-methyl propanol-2

13. On passing H_2S in IInd group, the solution becomes milky. It is indicative of the prescnce of
(a) a reducing agent
(b) an oxidising agent
(c) cations
(d) none of these

14. The deep blue colour in borax bead test is imparted by
(a) cobalt (b) chromium
(c) nickel (d) iron

15. The strength of borax solution can be found by titrating with a standard solution of
(a) boric acid (b) HCl
(c) Na_2CO_3 (d) $KMnO_4$

16. The concentration of H_2S in a saturated solution is approximately
(a) 0.1 M (b) 0.3 M
(c) 1 M (d) 6 M

17. The normality of pure conc H_2SO_4 used in laboratory is
(a) 36 N (b) 24 N
(c) 12 N (d) 9 N

18. Which of the following has been replaced by thioacetamide in analytical chemistry ?
(a) H_2S (b) $(NH_4)_2CO_3$
(c) NH_4OH (d) $(NH_4)_2C_2O_4$

19. H_2S gives a black ppt with a solution of
(a) $CdCl_2$ (b) $CuCl_2$
(c) $ZnCl_2$ (d) $MgCl_2$

20. Which of the following is used to confirm Ni^{2+} ?
(a) $K_4[Fe(CN)_6]$ (b) Dimethylglyoxime
(c) Resorcinol (d) Benzidime

ANSWERS

1. Kinetic Theory of Matter

1. (a)   2. (a)   3. (c)   4. (d)
5. (b)   6. (b)   7. (d)   8. (d)
9. (c)   10. (a)   11. (c)   12. (d)
13. (d)   14. (d)   15. (b)   16. (a)
17. (d)   18. (d)

2. Mole

1. (d)   2. (c)   3. (b)   4. (a)
5. (b)   6. (b)   7. (a)   8. (d)
9. (c)   10. (b)

3. Thermochemistry and Thermodynamics

1. (c)   2. (d)   3. (c)   4. (d)
5. (d)   6. (b)   7. (b)   8. (c)
9. (c)   10. (b)   11. (a)   12. (b)
13. (d)   14. (b)   15. (b)   16. (b)
17. (a)   18. (d)   19. (d)   20. (a)
21. (c)   22. (a)   23. (d)   24. (b)
25. (a)   26. (a)   27. (a)   28. (b)
29. (c)   30. (b)

4. Solutions

1. (c)   2. (c)   3. (b)   4. (d)
5. (b)   6. (d)   7. (c)   8. (d)
9. (d)   10. (b)   11. (a)   12. (c)
13. (d)   14. (c)   15. (b)   16. (c)
17. (a)   18. (a)   19. (d)   20. (a)

5. Dilute Solutions

1. (b)   2. (c)   3. (a)   4. (d)
5. (b)   6. (c)   7. (b)   8. (a)
9. (b)   10. (c)   11. (c)   12. (b)
13. (d)   14. (d)   15. (b)

6. Ionic Equilibria

1. (d) 2. (a) 3. (d) 4. (a)
5. (a) 6. (d) 7. (a) 8. (b)
9. (b) 10. (d) 11. (a) 12. (b)
13. (b) 14. (c) 15. (d) 16. (b)
17. (b) 18, (d) 19. (c) 20. (a)
21. (c) 22. (c) 23. (d) 24. (c)
25. (c) 26. (d) 27. (c) 28. (a)
29. (b) 30. (d) 31. (d) 32. (a)
33. (a) 34. (a) 35. (b) 36. (d)
37. (b) 38. (a) 39. (a) 40. (a)
41. (b) 42. (a) 43. (d) 44. (a)
45. (a) 46. (c) 47. (c) 48. (c)

7. Chemical Kinetics and Photochemistry

1. (c) 2. (a) 3. (c) 4. (b)
5. (d) 6. (c) 7. (a) 8. (c)
9. (c) 10. (d) 11. (c) 12. (a)
13. (b) 14. (c) 15. (a) 16. (b)
17. (b) 18. (a) 19. (b) 20. (c)
21. (c) 22. (a)

8. Equilibrium and Catalysis

1. (c) 2. (a) 3. (c) 4. (b)
5. (b) 6. (c) 7. (d) 8. (b)
9. (b) 10. (a) 11. (b) 12. (c)
13. (a) 14. (d) 15. (b) 16. (d)
17. (c) 18. (d) 19. (d) 20. (b)
21. (b) 22. (b) 23. (a) 24. (c)
25. (a) 26. (c) 27. (b) 28. (b)
29. (c) 30. (b) 31. (d) 32. (d)
33. (d) 34. (a) 35. (b) 36. (b)
37. (b) 38. (a) 39. (d) 40. (b)
41. (b) 42. (c) 43. (b) 44. (a)
45. (a) 46. (a) 47. (b) 48. (b)

9. Electrochemistry

1. (b) 2. (b) 3. (c) 4. (d)
5. (a) 6. (a) 7. (b) 8. (c)
9. (d) 10. (b) 11. (c) 12. (a)
13. (d) 14. (a) 15. (a) 16. (c)
17. (d) 18. (c) 19. (b) 20. (d)
21. (d) 22. (b) 23. (c) 24. (c)

25. (c) 26. (d) 27. (b) 28. (a)
29. (b) 30. (b) 31. (a) 32. (a)

10. Colloids

1. (c) 2. (a) 3. (c) 4. (b)
5. (d) 6. (b) 7. (c) 8. (d)
9. (a) 10. (d) 11. (c) 12. (c)
13. (a) 14. (b) 15. (b) 16. (d)
17. (d) 18. (a) 19. (a) 20. (b)
21. (d) 22. (c)

11. Phase Rule

1. (a) 2. (a) 3. (d) 4. (d)
5. (c) 6. (c) 7. (b) 8. (d)

INORGANIC CHEMISTRY

12. Structure of the Atom

1. (d) 2. (a) 3. (d) 4. (a)
5. (a) 6. (a) 7. (b) 8. (a)
9. (d) 10. (c) 11. (b) 12. (a)
13. (a) 14. (b) 15. (a) 16. (b)
17. (d) 18. (d) 19. (a) 20. (c)
21. (a) 22. (d) 23. (a) 24. (c)
25. (c) 26. (a) 27. (c) 28. (d)
29. (c) 30. (d) 31. (a) 32. (c)
33. (a) 34. (b) 35. (a) 36. (d)
37. (d) 38. (a) 39. (d) 40. (d)
41. (a) 42. (a) 43. (c) 44. (a)
45. (b) 46. (b) 47. (b) 48. (a)
49. (a), (c)

13. Periodic Classification

1. (d) 2. (b) 3. (c) 4. (c)
5. (c) 6. (b) 7. (a) 8. (d)
9. (d) 10. (a) 11. (d) 12. (b)
13. (d) 14. (a) 15. (c) 16. (d)
17. (b) 18. (d) 19. (a) 20. (a)
21. (a) 22. (a) 23. (c) 24. (d)
25. (a) 26. (d) 27. (a) 28. (d)
29. (b) 30. (c) 31. (b) 32. (c)
33. (a) 34. (b) 35. (b) 36. (a)
37. (b)

14. Chemical Bonds and Molecules

1. (c) 2. (a) 3. (c) 4. (b)
5. (a) 6. (c) 7. (b) 8. (d)
9. (c) 10. (a) 11. (c) 12. (a)
13. (b) 14. (b) 15. (a) 16. (d)
17. (a) 18. (c) 19. (b) 20. (d)
21. (d) 22. (d) 23. (a) 24. (d)
25. (a) 26. (a) 27. (b) 28. (d)
29. (a) 30. (c) 31. (b) 32. (c)
33. (c) 34. (c) 35. (c) 36. (d)
37. (a) 38. (c) 39. (d) 40. (a)

15. Nuclear and Radiochemistry

1. (d) 2. (d) 3. (b) 4. (a)
5. (b) 6. (c) 7. (a) 8. (b)
9. (c) 10. (b) 11. (b) 12. (c)
13. (a) 14. (d) 15. (a) 16. (a)
17. (c) 18. (c) 19. (a) 20. (b)
21. (c) 22. (a) 23. (d) 24. (b)
25. (d) 26. (c) 27. (b) 28. (b)
29. (d) 30. (a) 31. (d) 32. (b)
33. (c) 34. (d) 35. (d) 36. (b)
37. (a)

16. Oxidation and Reduction

1. (b) 2. (c) 3. (a) 4. (b)
5. (a) 6. (b) 7. (b) 8. (b)
9. (c) 10. (b) 11. (a) 12. (b)
13. (a) 14. (d) 15. (d) 16. (c)
17. (d) 18. (d) 19. (d) 20. (a)
21. (c) 22. (b) 23. (d) 24. (a)
25. (c)

17. Metallurgical Operations

1. (a) 2. (c) 3. (b) 4. (b)
5. (b) 6. (a) 7. (b) 8. (a)
9. (a) 10. (d) 11. (d) 12. (b)
13. (d) 14. (d) 15. (a) 16. (c)
17. (b) 18. (d) 19. (b) 20. (a)
21. (a) 22. (c) 23. (c) 24. (b)
25. (b) 26. (b) 27. (a) 28. (d)
29. (c) 30. (d) 31. (b) 32. (b)

18. Transition Elements

1. (b) 2. (a) 3. (d) 4. (d)
5. (d) 6. (a) 7. (c) 8. (d)
9. (b) 10. (d) 11. (a) 12. (c)
13. (b) 14. (c) 15. (d) 16. (b)
17. (c) 18. (d) 19. (c) 20. (b)
21. (a) 22. (d) 23. (b) 24. (d)
25. (a) 26. (a) 27. (d) 28. (d)
29. (b) 30. (c) 31. (a) 32. (d)
33. (b) 34. (d) 35. (a) 36. (b)
37. (b)

19. Oxidation and Reduction

1. (a) 2. (b) 3. (d) 4. (c)
5. (d) 6. (a) 7. (c) 8. (a)
9. (a) 10. (a)

20. Zero Group

1. (d) 2. (c) 3. (a) 4. (b)
5. (b) 6. (a) 7. (c) 8. (d)
9. (a) 10. (a) 11. (b) 12. (a)
13. (a)

21. Hydrogen, Water and Hydrogen Peroxide

1. (d) 2. (c) 3. (d) 4. (b)
5. (c) 6. (b) 7. (d) 8. (b)
9. (b) 10. (b) 11. (a) 12. (a)
13. (b) 14. (d) 15. (d) 16. (d)
17. (d) 18. (d) 19. (a) 20. (b)
21. (a) 22. (c) 23. (d) 24. (b)

22. Group IA—Alkali Metals

1. (d) 2. (b) 3. (d) 4. (d)
5. (b) 6. (d) 7. (a) 8. (c)
9. (a) 10. (a) 11. (c) 12. (a)
13. (a) 14. (d) 15. (d) 16. (b)
17. (b) 18. (c) 19. (b) 20. (a)
21. (d) 22. (d) 23. (b) 24. (b)
25. (a) 26. (c) 27. (d) 28. (c)
29. (d)

23. Group IIA—Alkaline Earths

1. (d) 2. (d) 3. (b) 4. (d)
5. (c) 6. (b) 7. (c) 8. (a)

9. (b) 10. (c) 11. (d) 12. (a)
13. (d) 14. (a) 15. (b) 16. (c)
17. (b) 18. (d) 19. (c) 20. (c)
21. (b) 22. (b) 23. (a) 24. (c)
25. (b)

24. Group III A Elements

1. (a) 2. (d) 3. (a) 4. (a)
5. (b) 6. (d) 7. (d) 8. (c)
9. (c) 10. (c) 11. (c) 12. (a)
13. (a) 14. (d) 15. (b) 16. (a)
17. (c) 18. (d) 19. (c) 20. (d)
21. (b) 22. (b) 23. (a) 24. (d)
25. (a) 26. (a) 27. (b)

25. Group IV A Elements

1. (b) 2. (b) 3. (d) 4. (d)
5. (a) 6. (c) 7. (d) 8. (b)
9. (d) 10. (c) 11. (c) 12. (c)
13. (d) 14. (c) 15. (a) 16. (c)
17. (b) 18. (d) 19. (a) 20. (b)
21. (d) 22. (b) 23. (b) 24. (c)
25. (c) 26. (a) 27. (b)

26. Group V A—Elements

1. (a) 2. (c) 3. (d) 4. (c)
5. (a) 6. (d) 7. (c) 8. (a)
9. (c) 10. (d)

27. Group VI A--Elements

1. (d) 2. (d) 3. (d) 4. (a)
5. (d) 6. (d) 7. (a) 8. (a)
9. (b) 10. (d) 11. (d) 12. (d)
13. (c) 14. (a) 15. (d)

28. Group VII A Elements

1. (a) 2. (a) 3. (b) 4. (d)
5. (b) 6. (a) 7. (b) 8. (c)
9. (b) 10. (b) 11. (d) 12. (d)
13. (a) 14. (d) 15. (a) 16. (c)
17. (b) 18. (d) 19. (b) 20. (a)
21. (a) 22. (c) 23. (b) 24. (c)
25. (a) 26. (b) 27. (a) 28. (b)

30. Introduction to Organic Chemistry

1. (a) 2. (d) 3. (b) 4. (d)
5. (c) 6. (b) 7. (b) 8. (a)
9. (c) 10. (c) 11. (d) 12. (a)
13. (d) 14. (b) 15. (a)

31. Reaction Mechanism

1. (a) 2. (c) 3. (d) 4. (d)
5. (b) 6. (c) 7. (c) 8. (c)
9. (a) 10. (a)

32. Hydrocarbons

1. (d) 2. (a) 3. (d) 4. (b)
5. (a) 6. (b) 7. (a) 8. (c)
9. (c) 10. (a) 11. (a) 12. (c)
13. (b) 14. (b) 15. (d) 16. (a)
17. (a) 18. (b) 19. (c) 20. (a)
21. (a) 22. (c) 23. (c) 24. (b)
25. (d) 26. (b) 27. (b) 28. (b)
29. (d) 30. (a) 31. (b) 32. (c)

33. Halogen Compounds

1. (d) 2. (d) 3. (d) 4. (a)
5. (b) 6. (a) 7. (d) 8. (d)
9. (d) 10. (c) 11. (d) 12. (c)
13. (d) 14. (a) 15. (b) 16. (b)
17. (a) 18. (d) 19. (c) 20. (b)
21. (d)

34. Alcohols and Phenols

1. (c) 2. (b) 3. (a) 4. (a)
5. (b) 6. (b) 7. (b) 8. (c)
9. (d) 10. (b) 11. (c) 12. (a)
13. (b) 14. (b) 15. (a) 16. (d)
17. (d) 18. (c) 19. (c) 20. (b)
21. (a) 22. (b) 23. (b) 24. (d)
25. (a) 26. (c) 27. (b)

35. Aldehydes and Ketones
(Carbonyl Compounds)

1. (d) 2. (c) 3. (d) 4. (b)
5. (b) 6. (c) 7. (b) 8. (a)
9. (d) 10. (c) 11. (d) 12. (c)

13. (d) 14. (a) 15. (d) 16. (b)
17. (d) 18. (a) 19. (c) 20. (c)
21. (a) 22. (a) 23. (a) 24. (d)
25. (b) 26. (a) 27. (c) 28. (c)
29. (b)

36. Ethers

1. (d) 2. (d) 3. (b) 4. (c)
5. (d) 6. (b) 7. (b) 8. (a)
9. (b) 10. (b)

37. Carboxylic Acids s

1. (d) 2. (a) 3. (a) 4. (c)
5. (b) 6. (c) 7. (c) 8. (b)
9. (b) 10. (c) 11. (c) 12. (b)
13. (b) 14. (a) 15. (b) 16. (a)
17. (a) 18. (c) 19. (c) 20. (c)
21. (b) 22. (a) 23. (c) 24. (a)
25. (a) 26. (d) 27. (b) 28. (c)
29. (c) 30. (b)

38. Amines, Amides and Esters

1. (d) 2. (c) 3. (a) 4. (c)
5. (b) 6. (a) 7. (a) 8. (b)
9. (b) 10. (b) 11. (c) 12. (a)
13. (b) 14. (d) 15. (c) 16. (c)
17. (a) 18. (d) 19. (a) 20. (c)
21. (b) 22. (b) 23. (a) 24. (b)

39. Carbohydrates

1. (a) 2. (b) 3. (b) 4. (c)
5. (c) 6. (d) 7. (c) 8. (c)
9. (c) 10. (c) 11. (b) 12. (d)
13. (c) 14. (d)

40. Stereochemistry

1. (a) 2. (c) 3. (c) 4. (a)
5. (d) 6. (b) 7. (c) 8. (d)
9. (a) 10. (b) 11. (d) 12. (d)
13. (c)

41. Diazonium Salts and Nitro Compounds

1. (a)
2. (d)
3. (a)
4. (c)
5. (c)
6. (c)
7. (a)
8. (b)
9. (b)
10. (d)

42. Miscellaneous Questions

1. (b)
2. (c)
3. (c)
4. (d)
5. (a)
6. (d)
7. (c)
8. (c)
9. (c)
10. (c)
11. (a)
12. (c)
13. (a)
14. (a)
15. (a)
16. (d)
17. (b)
18. (d)
19. (a)
20. (c)
21. (b)
22. (d)
23. (c)

45. Questions Based on Problems

1. (c)
2. (c)
3. (d)
4. (d)
5. (c)
6. (c)
7. (d)
8. (c)
9. (a)
10. (c)
11. (d)
12. (b)
13. (a)
14. (a)
15. (d)
16. (d)
17. (d)
18. (b)
19. (d)
20. (c)
21. (a)
22. (a)
23. (c)
24. (d)
25. (d)
26. (c)

46. Qualitative and Quantitative Analysis

1. (c)
2. (a)
3. (d)
4. (b)
5. (b)
6. (d)
7. (b)
8. (c)
9. (c)
10. (a)
11. (c)
12. (d)
13. (b)
14. (a)
15. (b)
16. (d)
17. (a)
18. (a)
29. (b)
20. (b)

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